DOCUMENT RESUME

ED 130 714 JC 760 595

AUTHOR	Hunter, David
TITLE	Nuclear Medicine Technology: A Suggested Two-Year Curriculum Manual.
INSTITUTION	North Carolina State Dept. of Community Colleges, Raleigh.
PUB DATE	Jun 75
NOTE	163p.
EDRS PRICE	MF-$0.83 HC-$8.69 Plus Postage.
DESCRIPTORS	Associate Degrees; Community Colleges; *Course Content; Course Descriptions; *Curriculum Guides; *Health Occupations Education; Health Personnel; *Junior Colleges; *Radiologic Technologists; State Curriculum Guides; Technical Education

ABSTRACT

This curriculum guide prescribes an educational program for training nuclear medicine technologists. Following a brief section on program development, the curriculum is both outlined and presented in detail. For each of the 44 courses, the following information is given: (1) sequential placement of the course in the curriculum; (2) course description; (3) course and lab hours per week; (4) quarter hours credit; (5) prerequisites; (6) suggested textbooks; (7) course objectives; and (8) detailed course outline. The nuclear medicine technologist curriculum spans eight academic quarters and leads to the Associate in Applied Science degree. Studies in the history, philosophy, and procedures of nuclear medicine technology are interwoven with studies in the basic physical and social sciences and English and with clinical practice at hospitals and other clinical agencies. In addition to the curriculum outline, admissions policies are suggested. Appended are: an outline of the essentials of an accredited educational program, job descriptions, a career ladder chart, a description and cost listing of necessary program equipment, and suggested supplies. (Author/JDS)

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NUCLEAR MEDICINE TECHNOLOGY

A SUGGESTED TWO-YEAR CURRICULUM MANUAL

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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JUNE, 1975

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RALEIGH, NORTH CAROLINA

JC 760 595

FOREWORD

The use of nuclear knowledge in the field of medicine is practically new to medical science. In order to cope with this new knowledge, a new technology has evolved with the responsibility placed upon the Community College System for the education and training of nuclear medicine technologists to meet the needs of all medical practitioners and agencies who are engaged in ministering to the health of all our people.

This curriculum, developed in the Forsyth Technical Institute, Winston-Salem, North Carolina, prescribes an educational program for training nuclear medicine technologists. Material is presented for the development of such a program and a suggested curriculum is outlined in detail. In order to give reality to the program, it will be noted that the instructional phase of the program is meshed with corresponding clinical aspects provided by nearby hospitals or other clinical agencies. It will be noted also that certain general education courses, particularly those related and necessary for a well-rounded education for the completion of the program, have been included.

The implementation of nuclear medicine technology as a program in any technical institute or community college requires a detailed study of the area employment opportunities, student potential and a thorough study of classroom, laboratory, and clinical facilities. The success of this program depends heavily upon the students obtaining appropriate clinical experiences in modern health care facilities utilizing nuclear medicine.

Roger G. Worthington

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ACKNOWLEDGEMENTS

This manual has been developed by David Hunter, Director, Nuclear Medicine Technology Training, Forsyth Technical Institute, Winston-Salem, North Carolina. He had the assistance of James R. Winning, Head, Department of Allied Health Sciences, Forsyth Technical Institute, in reviewing the first draft and in making many valuable suggestions. Mrs. Karen Bowen typed this first draft. Appreciation is expressed to each of these persons for their respective contributions.

Special recognition is expressed to Mrs. Marsha Baggett, Chief Nuclear Medicine Technologist, North Carolina Baptist Hospital, Winston-Salem, North Carolina, for her contribution of the job descriptions. In addition, acknowledgements are made to the following persons who have directly or indirectly assisted with this manual: Chauncey M. Lane, artist illustrator; Dr. Robert Cowan, Department of Nuclear Medicine, Bowman Gray School of Medicine, Winston-Salem, North Carolina for the course outline in Clinical Nuclear Medicine; Shelton Goforth, Anatomy and Physiology Instructor at Forsyth Technical Institute for the course outlines in BIO 123, 124, 125, 126, and 139; Mrs. Betty D. Chase, Math Instructor at Forsyth Technical Institute for the course outlines in MAT 124 and 125; Mrs. Vercie Eller, Assistant Director, Health Occupations, Department of Community Colleges, for final review and coordination of the program with other required courses in the health program; L. H. Jobe, former Director of Publications, State Department of Public Instruction, for editorial assistance; William F. Pugh, Artist Illustrator, Department of Community Colleges, for cover design and other art work; and Barbara Robbins Greess for typing the manuscript for duplication.

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PROGRAM DEVELOPMENT

INTRODUCTION

Nuclear medicine's modern era began shortly before World War II when artificially produced radionuclides first became available. Since that time, the specialty of nuclear medicine has developed into one of the most exciting and important components of modern biomedical science.

An increasing number of nuclear medicine technology programs have been established in hospitals, junior or community colleges, and universities. Nationally, the trend is away from two-year hospital programs. In providing a two-year curriculum in the community colleges, the nuclear technology student is given the opportunity to pursue general education courses as well as technical courses for a well-rounded background which gives him the flexibility that today's nuclear medicine departments and schools require.

ADVISORY COMMITTEE

The Council on Medical Education of the American Medical Association states that when there is an affiliation between a hospital and an accredited college or institute to provide an educational program, an advisory committee shall be appointed locally by the educational institution. This committee shall include representatives from both the hospital and the involved departments of the eudcational institutuion with the program director as an exofficio member. It will give advice and consultation on program development and evaluation, but will have no administrative function.

Members selected for the committee should represent not only the educational isntitution and clinical facilities participating in the program, but also members of the North Carolina Society of Nuclear Medicine, community leaders, and health occupations. However, since this must be a working committee, the total number should not be so large as to become unwieldy. This committee should evaluate the necessary studies to determine the degree of local need and availability of facilities and teaching personnel for establishing a successful program. They should act as the liaison between the program and the community, interpreting it to the community and encouraging its support. This committee also may supply information on employment and job opportunities. Once the educational program has been established and approved, the role of the advisory committee should provide more assistance in student and faculty recruitment and in the development of a continuing evaluation of the program.

The committee should be self-governing and should meet at least once a year. Minutes of the meetings should be kept on file in the program director's office, with copies sent to each member. In areas where the educational institution has a large general advisory committee, the consultant group for nuclear medicine technology education may be a subcommittee of the larger group.

ADMINISTRATION

General Comments

The program for nuclear medicine in a two-year community college or technical institute is acceptable to the Council on Medical Education of the American Medical Association, provided the institution is accredited and has clinical affiliations with approved medical schools or nuclear medicine departments which are affiliated with accredited general hospitals. Under certain circumstances, schools may be developed in specialty hospitals which have demonstrated capabilities of providing suitable training in nuclear medicine.

The program must be directed by a licensed physician. He should be well qualified, experienced, and proficient in his specialty. He should be eligible for certification or already certified by the American Board of Nuclear Medicine.

The medical director must be a faculty appointment responsible for the overall development, implementation, and evaluation of the program. The nuclear medicine faculty and the educational institution should work together to design a program that fits within the framework of the institution.

Each proposed or existing program should have a clearly written statement of its philosophy and objectives which are reflected in a curriculum according to State Board of Education policy. This curriculum should be flexible enough to allow the shifting of courses of study from one quarter to another in order to meet the needs of the student body, as well as to fit into specific course offerings of the educational institution and the clinical resource facilities.

The statement of philosophy should include an expression of belief in the nature of the academic program proposed for nuclear medicine technologists and belief in freedom of inquiry. The statement should indicate the responsibility of the educational institution to prepare the student for his professional role and to have concern for him as an individual. A declaration of intention of the nuclear medicine program to correlate its philosophy with the overall philosophy of the educational institution should also be included.

The educational institution will:

1. Develop an educational program that will insure a level of quality which will prepare the student to practice his profession effectively.

2. Maintain a program valid to the needs and resources of the community.

3. Provide flexibility within the program to meet the needs of individual students.

4. Provide an opportunity for academic progression for nuclear medicine technology students who desire to continue beyond the requirements of an associate in applied science degree.

A follow-up study of the graduates from the program in such areas as place of employment, functions, and quality of services is very useful in evaluating the program and planning revisions to improve both the program and its product. Feedback from the students at the end of the academic year can also be helpful in improving an individual instructor's classroom technique, provided this can be given and accepted objectively.

Faculty

In addition to the director of the program, there should be an adequate number of qualified instructors to teach the classroom and laboratory course work and sufficiant clinical faculty to instruct and supervise students in the clinical portions of the program. The number of faculty needed will depend upon the number of courses offered during an academic term, the number of students registered in any given course, the number of classes registered during an academic term, and faculty responsibilities other than teaching.

Teaching in the clinical area may require a greater number of instructors than is needed in the classroom. According to the Council on Medical Education, there must be at least one qualified technologist instructor for every three students. To meet this requirement, additional teachers may be considered for part-time employment in the clinical facilities to assist with the supervision of students. Employment on a part-time basis in the classroom will depend on need and the policy of the educational institution. A part-time teacher should meet the same qualifications as a full-time teacher. It is strongly recommended that a prospective instructor who would function in a clinical facility be acceptable to, and approved by, that facility before employment by the educational institution.

Qualifications. The director of the program must be a duly licensed physician experienced and proficient in the specialty of nuclear medicine. Any exception to these qualifications must be ruled upon by the Council on Medical Education of the American Medical Association.

There should be at least one instructor who is a trained nuclear medicine technologist who may serve as assistant director of the program. He should have a minimum of three years of practical working experience and a baccalaureate degree. Faculty members should be well-trained technologists who are able to assist in classroom instruction and in teaching students.

They should be registered or eligible for registration by the American Registry of Radiologic Technologists (ARRT) or the American Society of Clinical Pathologists (ASCP) and have teaching ability. They should have a minimum of one year of clinical experience.

Professional Growth. The teacher, although prepared academically in his specialty, needs to keep abreast of the rapid changes which are occurring in his field. For this reason, he should try to attend some of the many short courses offered by various continuing education programs. The community colleges also present courses on educational trends and methods which are required for technology teachers and may also be useful to the faculty in a health program. Periodic meetings and workshops, sponsored by the Department of Community Colleges, are held for all health education faculty.

Participation in professional organizations, both on a state and national level, provides an atmosphere for an exchange of ideas and identification of trends within nuclear medicine technology. Meetings of such organizations provide opportunities to gather new ideas from recognized leaders in areas of specialization or in methods of problem-solving. Opportunities to attend meetings, workshops, and short courses should be given to all faculty members.

Scheduled faculty meetings should be held regularly, usually weekly, where more than one teacher is employed. Minutes should be recorded and filed. These meetings act as a forum to distribute information, to discuss problems in the classroom, and to evaluate the program. When possible, clinical instructors should also be included in these meetings. At least one general meeting should be held each year.

Services and Facilities

1. Student health and counseling services should be available.

2. Library facilities, with an adequate number and variety of books, periodicals, and up-to-date reference materials related to the curriculum, should be readily accessible. Some provision should be made for the continuing acquisition of new materials, with participation in their selection by the faculty of the nuclear medicine program.

3. Classroom facilities. The educational institution is responsible for providing sufficient space, light, and modern equipment for classroom instruction. If possible, a basic practice laboratory and classrooms should be separate from the hospital areas which are used as clinical resources. However, conference and classroom space should be provided in the clinical area in addition to the clinical facilities if a regular classroom is not easily accessible. The number and size of classrooms needed is dependent upon student enrollment and whether available classrooms are to be utilized by students of allied health programs.

There should be at least one laboratory, either on campus or in a nearby nuclear medicine department, with the needed, up-to-date equipment for demonstration and laboratory practice. An energized laboratory on campus is desirable and will eliminate the need to schedule practice time in the affiliating hospital off campus. Such a laboratory will solve the problems of transportation, scheduling of student and patients; and relieve the clinical facility in providing this space and equipment. Sufficient electrical power and power outlets should be designed into the laboratory.

Nuclear medicine equipment, laboratory supplies, and audiovisual aids should be provided in the number and variety needed for effective classroom and laboratory teaching and learning. Adequate space should be provided for storage of this equipment and these teaching aids in close proximity to both the classroom and the laboratory. Dressing rooms, lockers, lavatories, and toilets should adjoin, or be readily accessible, to the laboratory area.

4. Equipment. The amount and kind of equipment in the classroom areas should be planned to complement and supplement the equipment available for student instruction and practice in the clinical areas. A basic equipment list for nuclear medicine technologist education will be found in Appendices C and D.

5. Textbooks. Textbooks for the major areas of instruction are chosen by the educational institution for purchase by the student. Choice of textbooks should be considered carefully by the teachers in the program for recommendation to the appropriate administrative officer.

6. Office space. The director of the program should be provided with facilities suitable for interviews, counseling, and testing, with space for filing records. Desk space should also be made available for teachers in both clinical and classroom areas of the program when these areas are located in separate buildings.

7. Records. Satisfactory records shall be kept of all work carried on in the program. These include the students' college transcripts and other credentials, their classroom attendance and grades, and the number and types of technical procedures they have performed. An outline of the curriculum and the rotation of assignments shall be available in the director's office.

8. Safety. The program director is responsible for compliance with standard safety regulations in regard to working conditions and exposure to radiation in classroom and laboratory areas as outlined in Handbook 76, United States government publication.

9. Clinical facilities. Health care facilities for student clinical experience must be available in sufficient quantity and variety of case load. Each facility must have adequate nuclear medicine technology staff for supervision (one instructor for every three students)

and space to provide meaningful learning experiences for students who are enrolled in the program. The clinical resources are so important to the success of the education program that the number of students accepted in a given class must be limited according to the clinical facilities available.

Health care facilities which are utilized in the clinical portions of the program must meet the requirements for accreditation by the Joint Commission on Accreditation of Hospitals. These may be nuclear medicine departments affiliated with accredited general hospitals or departments within approved medical schools.

In order to prevent overloading of the clinic staff and to assure adequate learning experiences and proper student supervision, the clinical resource agency should be considered for technical programs of nuclear medicine technology only when there is no conflict with existing educational programs. If the medical agency thinks that it can cope with groups of students from more than one educational institution, this is acceptable. Provision for student liability coverage should be discussed and planned for by the educational institution and the clinical affiliates.

10. Contracts with Clinical Facilities.* The administrations of the educational institution and the clinical resource agencies should contract in writing to provide the experiences which will meet all objectives of the clinical practice portion of the program and still preserve the primary objectives of the clinical center. Much dissatisfaction and disillusionment can be avoided by having a written document that is readily available for reference if a problem should arise.

The greatest value in writing a contract is the necessity forced upon the personnel in the local educational institution and the clinical center to discuss each item of possible involvement or concern. In considering the major provisions of the contract, the thinking of both the institution and the center becomes blended. Thus, potential problems and issues are faced and solutions planned before any need actually occurs. The written contract leads to a much better understanding of the roles and responsibilities of each party than a standard, fill-in-the-blanks contract can provide; and a more harmonious relationship should result.

There are three areas covered by a contract (letter of agreement or memorandum of agreement): (1) items to which the educational institution agrees; (2) items to which the clinical center agrees; and (3) mutual agreements. The major items for discussion are:

a. The purposes and objectives of the relationship which are being agreed to from both points of view.

b. The exchange of basic promises and understandings.

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*M. Moore, M. Parker, and S. Nourse. Form and Functions of Written Agreements for Clinical Education of Health Science Student. Throughfare, New Jersey: Charles Slack, Publisher, 1972.

c. Specific responsibilities of the educational institution, such as discipline of students, adequate training before students are sent out, and adequate information about the students.

d. Specific responsibilities of the clinical center, such as adequate supervision of students, use of clinical facilities, and provision for a range of learning experiences.

e. Specific benefits to the clinical center, such as the opportunity to attend educational symposia and college-level courses, use of educational institution facilities, and possible faculty appointments.

f. Rights and responsibilities of, and benefits to, students, such as room and board, health care and sick leave, travel expenses, holidays, and status of student (some institutions regard them as temporary employees).

g. Mechanics for the maintenance, modification, arbitration, coordination, and renewal or termination of the contract.

h. Signatures and dates. There should be two signatures representing each party to the contract; for instance, the nuclear medicine technologist who is the director of the educational program and the appropriate administrative official of the local educational institution as one party and the director of the nuclear medicine department and his hospital administrator as the other.

The best contract is short, simple, general and flexible. Important but constantly changing details, such as schedules and numbers of affiliating students or the assignment of the faculty to the clinic staff, are better appended to the basic contract by letter rather than written into the body of the contract. The mechanism for determining these items however should be included in the contract. If money is involved, a lawyer should definitely be consulted. It is wise to have a lawyer review any written agreement drafted by the parties involved prior to signing it, whether money is involved or not, in order to determine if it is valid and in keeping with the laws of the state. A non-discrimination clause covering staff, students, and patients should be included.

Selection of Students

The recruitment and selection of students is the responsibility of the educational institution.

Suggested criteria are:

1. A high school graduate or a person with a passing score on the high school equivalency or GED test. The student should have completed

courses in chemistry, biology, and algebra. If a student is lacking in these courses, he should take them prior to enrollment in the nuclear medicine program.

2. A score of 800 or more on the Scholastic Aptitude Tests of the College Entrance Examination Board or satisfactory scores (55% or better on Reading, English and Math) on the Comparative Guidance and Placement Test.

3. A senior high school class ranking in the upper 33% is suggested.

4. Three references, one of which should be from a former teacher or guidance counselor if possible.

5. A pre-entrance health examination prior to admission showing evidence of good health and successful vaccination.

6. Applicant's age preferably should be between 18 and 45 years.

7. A personal interview with the counselor of the health program and a member of the faculty of the nuclear medicine program.

Assistance and information concerning scholarships, loans and grants in aid should be made available to applicants. Students should understand the conditions under which such funds are made available and the obligations of applicants who receive them. The counseling services of high schools, technical institutes, and community colleges are available for assistance to students needing financial aid.

CURRICULUM

The Associate in Applied Science degree will be awarded upon the successful completion of an eight-quarter period of study combining technical and general education courses. The classes are held at the institution's campus, whereas the clinical education is offered in the community health facilities. The history, philosophy, and procedures of nuclear medicine technology are interwoven with studies in the basic physical and social sciences and English. The general education courses may be elected from the general education program if the student desires to pursue a baccalaureate degree at a four-year institution in the future. Each of the courses in the curriculum should reflect its contribution to the philosophy, purposes, and objectives of the program. Courses should be developed and presented in a logical sequence that will provide optimum learning opportunities.

The Council on Medical Education of the American Medical Association recommends that a minimum of 410 clock hours of teaching be planned. This teaching may be done by lecture, individualized instruction, discussions and seminars, demonstrations, supervised practice, textbook assignments, reports, and review. The rest of the hours in the two-year program are spent in clinical practice. Proper student supervision in the clinic for all procedures should progress from the student's observing the instructor to assisting and gradually replacing the instructor. The instructor then observes the student performing the procedure until he is satisfied that the student can do it unaided, but with an instructor readily available should assistance be needed.

ACCREDITATION OF THE PROGRAM

Although the accreditation of a school or program of nuclear medicine technology is a voluntary procedure, it is the only standard of quality in existence which has national significance. In order for a student to be recognized by the ARRT or ASCP, he must have graduated from an American Medical Association approved program. It is known that employers usually seek only the registered technologists for employment, so accreditation of the school is vitally important to the future of the students.

STUDENT MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

Students should be given information concerning student membership in professional organizations on local, State, and national levels, and they should be encouraged to join some of these organizations. Membership in such organizations not only helps the student to develop a sense of the scope of his profession, the trends within it, and the problems facing it, but it also encourages him to maintain his membership after graduation and become active in the growth of nuclear medicine technology.

CAREER OPPORTUNITIES

Since the field of nuclear medicine is developing so rapidly, there is a growing demand for well-trained, highly motivated adaptable men and women.

Manpower studies indicate that in 1973 there were jobs for about 8,000 NMTs in the United States. By 1975, it is anticipated that this need for NMTs will increase to at least 10,000 to 11,000. These studies indicate the need to train more than 1,000 additional NMTs each year, and this number may be even larger with the continuing development and application of nuclear medicine technology. The major trends in nuclear medicine which may affect the number of technologists needed over the next few years include the use of faster scanners and cameras for imaging procedures, increased numbers of dynamic function studies, the development of materials labeled with radionuclides with shorter half-lives, and the use of more complex radio-pharmaceuticals and more automated data-handling facilities, including computers.

With the increasing demand for nuclear medicine services, opportunities are available in large and small hospitals, both public and private. At this stage in the development of nuclear medicine, there are only a few opportunities in veterans' administration hospitals, public health institutions, and national research institutes. In addition, the armed forces both train and employ NMTs. Also, the growing number of NMT training programs in hospitals, community colleges, and technical institutes provide openings for instructors in nuclear medicine technology.

SUGGESTED CURRICULUM BY QUARTERS

FIRST YEAR

Course Title

FIRST QUARTER

		C	L	P	QH
BIO 123	Anatomy and Physiology I	3	2	0	4
CHM 109	General Chemistry I	3	2	0	4
ENG 101	Grammar	3	0	0	3
MAT 124	Mathematics	3	0	0	3
BIO 125	Medical Terminology I	1	0	0	1
NMT 101	Nuclear Medicine Technology I	1	0	0	1
		14	4	0	16

SECOND QUARTER

		C	L	P	QH
BIO 124	Anatomy and Physiology II	3	2	0	4
ENG 102	Composition	3	0	0	3
CHM 110	General Chemistry II	3	2	0	4
MAT 125	Mathematics	3	0	0	3
BIO 126	Medical Terminology II	1	0	0	1
PHY 114	Physics	3	0	0	3
NMT 102	Nuclear Medicine Technology II	1	0	0	1
		17	4	0	19

THIRD QUARTER

		C	L	P	QH
CHM 202	Organic Chemistry	3	2	0	4
BIO 169	Fundamentals of Disease Processes	4	0	0	4
PHY 115	Physics	3	0	0	3
PSY 169	Social Psychology of Health and Illness	4	0	0	4
BIO 139	Topographical Anatomy	2	0	0	2
NMT 103	Nuclear Medicine Technology III	1	0	0	1
		17	2	0	18

FOURTH QUARTER

		C	L	P	QH
CHM 203	Biochemistry	3	2	0	4
NMT 125	Film Processing	1	2	0	2
NMT 104	Nuclear Medicine Technology IV	2	0	0	2
NMT 129	Practicum I	2	0	12	6
		8	4	12	14
	Total Hours - First Year	56	14	12	67

SECOND YEAR

Course Title

FIFTH QUARTER

		C	L	P	QH
NMT 116	Nuclear Physics	2	0	0	2
NMT 269	Practicum II	0	0	30	10
NMT 111	Principles of Nuclear Medicine I	2	0	0	2
NMT 255	Introduction to Radioimmunoassay	1	2	0	2
NMT 268	Open Lab Practicum I	0	0	6	2
		5	2	36	18

SIXTH QUARTER

		C	L	P	QH
NMT 274	Practicum III	0	0	30	10
NMT 230	Nuclear Medicine Instrumentation I	3	2	0	4
NMT 221	Principles of Nuclear Medicine II	2	0	0	2
NMT 223	Radiopharmaceuticals I	2	0	0	2
NMT 117	Health Physics	1	0	0	1
NMT 273	Open Lab Practicum II	0	0	6	2
		8	2	36	21

SEVENTH QUARTER

		C	L	P	QH
NMT 279	Practicum IV	0	0	30	10
NMT 240	Nuclear Medicine Instrumentation II	3	2	0	4
NMT 241	Principles of Nuclear Medicine III	2	0	0	2
NMT 289	Radiobiology	2	0	0	2
NMT 233	Radiopharmaceuticals II	2	0	0	2
NMT 278	Open Lab Practicum III	0	0	6	2
		8	2	36	22

EIGHT QUARTER

		C	L	P	QH
NMT 284	Practicum V	0	0	36	12
NMT 251	Principles of Nuclear Medicine IV	2	0	0	2
NMT 290	Nuclear Medicine Technology Seminar	2	0	0	2
NMT 283	Open Lab Practicum IV	0	0	6	2
		4	0	42	18
	Total Hours - First Year	56	14	12	67
	Total Hours - Second Year	25	6	150	79
	Total Hours for Program	81	20	162	146

COURSE DESCRIPTIONS BY QUARTERS

FIRST YEAR

FIRST QUARTER	Class	Lab	Prac-ticum	Quarter Hours Credit
BIO 123 Anatomy and Physiology I	3	2	0	4
An introduction to normal structure and function of the human body on a cellular level, including tissues, organs, and organ systems. When relevant, clinical applications are briefly made of such acquired knowledge, e.g. relation of information to basic pathological states. The laboratory experience introduces additional fundamentals gained by personal participation in various types of exercises.				
CHM 109 General Chemistry I	3	2	0	4
Study of the physical and chemical properties of substances, chemical changes, elements, compounds, gases, chemical combinations, weight and measurements, theory of metals, acids, bases, salts, solvents, solutions, and emulsions. In addition, study of carbohydrates, electrochemistry, electrolytes, and electrolysis. Industrial and agricultural applications are emphasized.				
ENG 101 Grammar	3	0	0	3
Designed to aid the student in the improvement of self-expression through writing. Emphasis is on grammar, diction, sentence structure, punctuation, and spelling. It is intended to stimulate students in applying the basic principles of English grammar in their day-to-day situations in industry and social life.				
MAT 124 Mathematics	3	0	0	3
The first of a series of two courses designed to develop and maintain a high level of proficiency in mathematical skills and algebra fundamentals. Topics covered include: Fundamental facts about whole numbers, fractions, percents, slide rule, expanded notation, positive and negative numbers, functions and graphs, trigonometric functions, and linear equations.				
BIO 125 Medical Terminology I	1	0	0	1
The first of a series of two courses which include terms related to all areas of medical science, hospital service, and paramedical specialties. Terms introduced parallel the topics covered in Anatomy and Physiology I.				
NMT 101 Nuclear Medicine Terminology I	1	0	0	1
An orientation to the field of nuclear medicine technology. Elementary patient care procedures and professional ethics are emphasized.				

SECOND QUARTER

BIO 124 Anatomy and Physiology II 3 2 0 4

This course is a continuation of the study of the normal structure and function of man. Emphasis is on the circulatory, lymphatic, respiratory, digestive, urinary, reproductive and endocrine systems, and fluid and electrolyte balance. Laboratory experiences include small animal dissections and physiology experiments to augment the students' understanding of body structure and function.

ENG 102 Composition 3 0 0 3

English composition is designed to aid the student in the improvement of self-expression by means of practical application in business and technical writing. Emphasis is on writing sentences, paragraphs, and compositions.

CHM 110 General Chemistry II 3 2 0 4

This is a continuation of CHM 101 with an introduction to solutions, oxidation and reduction, electrochemistry, and radioactivity.

MAT 125 Mathematics II 3 0 0 3

The second of a series of two courses designed to develop and maintain proficiency in basic mathematical skills. Topics covered are: quadratic equations, exponents and radicals, logarithms, ratio and proportion, metric and apothecaries' system of measurement, and mathematics of drugs and solution.

BIO 126 Medical Terminology II 1 0 0 1

The second of a series of two courses in which terms related to all areas of medical science, hospital service, and paramedical specialties are introduced.

PHY 114 Physics 3 0 0 3

An introductory physics course intended for those who have not had previous study in the field. Basic concepts in kinematics, heat, light, sound, electricity, and atomic physics are stressed.

NMT 102 Nuclear Medicine Technology II 1 0 0 1

An introduction to the radiopharmaceuticals and instrumentation used in nuclear medicine. Radiation safety procedures will be discussed.

THIRD QUARTER

CHM 202 Organic Chemistry 3 2 0 4

A study of nomenclature, variety, usefulness, and most significant properties of selected organic compounds.

BIO 169 Fundamentals of Disease Processes 4 0 0 4
An introduction to the major processes involved in producing pathological entities and disorders in man and how such states interfere with normal physiology. This knowledge of diseases and abnormal states is correlated with the more commonly seen pathology in clinical practices. Emphasis will be placed upon the fundamental principles of microbiology, the relationship of microorganisms to disease, modes of transmission, control, and the etiological agents of infectious diseases.

PHY 115 Physics 3 0 0 3
A study of basic electronics and electronic instruments, their theory of operation, function, tolerances, and calibration. Principles of both service and laboratory instruments will be studied. Also, basic principles of nuclear physics are included.

PSY 169 Social Psychology of Health and Illness 4 0 0 4
A study of how culture is related to illness. Both the psychological and sociological factors will be investigated. The cultural principles attributed to illness, symptoms of illness, and situations associated with illness are studied. How illness affects family patterns and development, and how psychological and sociological principles affect patient-professional, family-patient, and family-professional relationships are included.

BIO 139 Topographical Anatomy 2 0 0 2
A study for visualizing the patient's surface anatomy. Major emphasis is placed on learning the topographical location of internal organs, muscles, nerves and nerve plexuses, blood vessels, bony prominences, and techniques of palpation of structures not visually evident. Radiology is stressed throughout the course, since the technique defines structures not recognized by visual inspection or palpation. Living anatomy is stressed throughout the course, so that surface landmarks and palpations are constant reminders of deeper structures.

NMT 103 Nuclear Medicine Technology III 1 0 0 1
A study of the in vivo nuclear medicine procedures. Patient preparation for these procedures will be emphasized.

FOURTH QUARTER

CHM 203 Biochemistry 3 2 0 4
The chemistry of the main classes of compounds of biological importance and the major metabolic process of living organisms are discussed.

NMT 125 Film Processing 1 2 0 2
A study of theory and practice in processing exposed radiographic plates. Demonstrations of proficiency for distinctly readable final product are required.

NMT 104 Nuclear Medicine Technology IV 2 0 0 2
A continuation of the nuclear medicine technology which emphasizes special *in vitro* procedures.

NMT 129 Practicum I 0 0 12 4
Directed clinical learning experiences in special areas of the nuclear medicine laboratory. Radionuclide generators, radiation safety, and management and administration of nuclear medicine department will be presented in lecture series.

SECOND YEAR

FIFTH QUARTER

NMT 116 Nuclear Physics 2 0 0 2
An introduction of the student to the basic concepts of atomic and nuclear radiation physics. Nuclear decay schemes and concepts of radioactive decay are discussed, followed by a thorough discussion on the interactions of radiation with matter.

NMT 269 Practicum II 0 0 30 10
Practical experience in a clinical setting, with emphasis on scanning. Radiation protection practices and routine quality control of the instruments will be observed and used.

NMT 111 Principles of Nuclear Medicine I 2 0 0 2
An introductory course in clinical nuclear medicine. The basic principles of the major *in vivo* studies and major clinical nuclear medicine procedures will be introduced.

NMT 255 Introduction to Radioimmunoassay 1 2 0 2
A review of the basic units of measurement, with emphasis on the metric system. The organization of living matter from the chemical view is discussed. Emphasis will be placed on protein structure and competitive protein binding analysis.

NMT 268 Open Lab Practicum I 0 0 6 2
Clinical experience as conducted under evening and weekend emergency conditions.

SIXTH QUARTER

NMT 274 Practicum III
Practical experience in a clinical setting, with emphasis on the more advanced applications in nuclear medicine procedures. Preparation and use of radiopharmaceuticals; preparation of the patient for such studies as bone and ^{67}GA.

NMT 230 Nuclear Medicine Instrumentation I 3 2 0 4

A study of practical electronic design of radiation detection instruments and circuit construction. Use of such instruments as the Geiger-Muller counter, ionization chambers, proportional counters, and radiation monitoring devices are discussed. Statistics related to nuclear counting are introduced.

NMT 221 Principles of Nuclear Medicine II 2 0 0 2

Principles and applications of radionuclide studies of the gastrointestinal and cardiopulmonary systems.

NMT 223 Radiopharmaceuticals I 2 0 0 2

Introduction to radiopharmacy functions, production of radionuclides, quality control of radiopharmaceuticals, and radiopharmacy mathematics.

NMT 117 Health Physics 1 0 0 1

Introduction to radiation safety techniques for reducing exposure to physicians, technologists and patients. Atomic Energy Commission and State regulations, and monitoring methods for nuclear medicine departments will be emphasized.

NMT 273 Open Lab Practicum II 0 0 6 2

Clinical experience conducted under evening and weekend emergency conditions, with more emphasis on student participation in clinical procedures and patient contact.

SEVENTH QUARTER

NMT 279 Practicum IV 0 0 30 10

Practical experience in a clinical setting, with emphasis on in-vitro procedures and therapeutic use of radionuclides. The course will also relate all theory presented during the first three quarters of practicums.

NMT 240 Nuclear Medicine Instrumentation II 3 2 0 4

A study in detail of the use of well counter, scanners, cameras, single channel and multichannel analyzers as related to clinical nuclear medicine. Emphasis is placed upon NaI(Tl) detectors, GeLi detectors, amplifiers, spectrometers, ratemeter and scalers.

NMT 241 Principles of Nuclear Medicine III 2 0 0 2

Detailed consideration will be given to principles and applications of radionuclide studies of the endocrine and central nervous systems.

NMT 289 Radiobiology 2 0 0 2
A course in which the fundamentals of radiobiology, a system's sensitivity to radiation (normal and neoplastic), radiation pathology, and the biological effects of radiation are stressed. Emphasis is placed upon the effects of radiation and the effects of radiation absorption on tissue and tissue recovery rate.

NMT 233 Radiopharmaceuticals II 2 0 0 2
A study of radiopharmaceuticals used in nuclear medicine departments on a routine basis. Radiopharmaceuticals of historical and research interest will be emphasized.

NMT 278 Open Practicum III 0 0 6 2
Clinical experience conducted under evening and weekend emergency situations, with more emphasis on student participation in clinical procedures and patient contact.

EIGHTH QUARTER

NMT 284 Practicum V 0 0 36 12
A more detailed study in the design and use of specific instruments utilized in clinical nuclear medicine. Emphasis will be placed on the performance of more advanced studies in in-vitro and in vivo procedures employing radioisotopes and practical therapeutic use of radionuclides.

NMT 251 Principles of Nulcear Medicine IV 2 0 0 2
Detailed theoretical consideration of standard in vivo laboratory tests and to radionuclide studies of the skeletal and urinary systems are stressed.

NMT 290 Nuclear Medicine Technology Seminar 2 0 0 2
A review of any specific topics of nuclear medicine technology of special interest to students. Papers on such topics will be presented by guest speakers.

NMT 283 Open Lab Practicum IV 0 0 6 2
Clinical experience in NMT 284 as conducted under evening and weekend emergency conditions, with more emphasis on student participation in clinical procedures and patient contract.

COURSE OUTLINES

FIRST QUARTER

BIO 123 ANATOMY AND PHYSIOLOGY I

PLACEMENT: First Quarter

COURSE DESCRIPTION:

An introduction to normal structure and function of the human body on a cellular level, including tissues, organs, and organ systems. When relevant, clinical applications are briefly made of such acquired knowledge, e.g. relation of information to basic pathological states. The laboratory experience introduces additional fundamentals gained by personal participation in various types of exercises.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: None

SUGGESTED TEXTBOOK:

Anthony, Catherine P. and Kilthoff, Norma J., Textbook of Anatomy and Physiology. 8th ed. St. Louis: The C. V. Mosby Co., 1971.

Laboratory directions prepared by instructors.

COURSE OBJECTIVES:

1. Develop a vocabulary of scientific and medical terms which will facilitate communication between the student and his co-workers.
2. Understand own body mechanics and use of body more effectively in performing daily duties.
3. Apply knowledge of the normal body to the understanding of abnormal states, especially as viewed in daily contacts with patients.
4. Understand that the body, while studied in separate systems for convenience, is actually an integrated whole, with every part affecting many other parts.
5. Understand that the functioning of any organ is a consequence of the functioning of its component cells and, in turn, their subcellular components.

6. Interrelate material learned in other courses to the knowledge gained in this course.

7. Understand scientific measurements, which for accuracy depend upon the controlled condition of the patient.

8. Look to the directions which are being taken by modern physiological research in order to become oriented toward watching for new developments in medicine and own specific field after graduation.

COURSE OUTLINE:

Unit Objective: View the gross subdivisions of the body and the cellular basis upon which these are founded.

Content	Learning Experiences
I. Organization of the Living Body	
A. Introduction to anatomy and physiology	
1. Divisions into subfields	Planes, cavities and organs of body
2. Definitions of directional terms and planes	Open freshly killed rabbit to see body plan, major organs, view of types of tissues
3. General plan of the vertabrate	Correlate with human torso
4. Concepts of homeostasis	
B. The cell	
1. Cell membrane	Use of the microscope: Practice
2. Cytoplasmic organelles	Microscope study:
3. Nucleus:	Stained cheek cells
a. DNA	Epithelial tissues
b. RNA	Connective tissues
c. Mitosis	Skin
C. Tissues	
1. Epithelial	Film: From One Cell (American Cancer Society)
2. Connective	
3. Membranes	Handout: The Cell (Upjohn Company)
D. Organs and systems	
E. The skin	
1. Structure	
2. Functions	

Unit Objective: Learn the skeletal components of the body and the elements of muscular movement which activate them.

Content	Learning Experiences
II. Framework of the Body	
A. Skeletal system	Study of skeleton
1. Functions	Demonstrations: Bones soaked in acid
2. Bone tissue	Bones baked
3. Bone development	Fresh bones
4. Divisions of skeleton	
B. Articular system	Study of beef joints
1. Types of articulations	Study of human joints from skeleton and selves
2. Types of movement possible in each	
C. Muscular system	Microscopic study of 3 types of muscle tissue
1. Histology of muscle tissue	
2. Attachments of actions of muscles	Study of attachments and actions of individual muscles on selves, torso, skeleton and embalmed cat
3. Muscle physiology	
D. Practical applications of musculo-skeletal information	Visit to Medical School anatomy laboratory to view muscles of human cadaver
1. Fractures	
2. Sprains	
3. Arthritis and bursitis	
4. Congenital abnormalities	
III. Integration by Nervous Control	
A. Nervous system	
1. Functions and divisions	Microscopic study of nervous tissue from cross section of spinal cord
2. Nerve tissue	
3. Reflex arc and act	Model of spinal cord and nerves
4. Nerve physiology	Demonstration: Reflexes of frog
5. Anatomy of nervous system	
a. Spinal cord	
b. Spinal nerves	
c. Meninges	
d. Spinal pathways and types of reflexes	

6. Brain
   a. Overall functions
   b. Development and general structure
   c. Parts and functions
7. Cranial nerves
8. Autonomic nervous system
   a. Function
   b. Anatomical difference
   c. Divisions and physiological differences
      (1) Thoraco-lumbar system
      (2) Cranio-sacral system
      (3) Effect of drugs on each

Dissection of sheep brain
Demonstration of human brain
Demonstration of fresh cow brain and meninges

B. Special senses
   1. Sensory pathways
   2. Cutaneous senses
   3. Proprioception
   4. Visceral afferents
   5. Taste and smell
   6. Vision
   7. Hearing
   8. Practical considerations of nervous system and special senses

Ox-eye dissection
Eye and ear models
Sensory and reflex experiments on selves

IV. Hematology - Circulatory System

Dissection directions prepared by instructor

A. Blood
   1. Formed elements
      a. Erythrocytes
      b. Leucocytes
      c. Platelets
   2. Plasma
   3. Clotting
   4. Antigenic types

Clotting time
Bleeding time
ABO grouping and Rh factors
Hematocrit
Hemoglobin test papers
Wright stain
Study histology
Hemolysis and crenation

B. Formation of tissue fluid and lymph

C. Exchange through membranes
   1. Filtration
   2. Diffusion
   3. Osmosis
   4. Active transport

FACILITIES FOR TEACHING:

1. Classrooms
2. Laboratory

EQUIPMENT FOR TEACHING:

1. Microscopes
2. Skeletons, mounted and disarticulated
3. Prepared slides
4. Human torso model and other models and charts
5. Movie, slide and filmstrip projectors
6. Films, slides and filmstrips

MATERIALS:

1. Human cadaver dissected especially for this course
2. Preserved animal specimens
3. Preserved human organs
4. Fresh specimens from slaughterhouse
5. Live frogs

REFERENCES:

Bloom, William and Don W. Fawcett. *Textbook of Histology*. 9th ed. Philadelphia: W. B. Saunders Co., 1968.

Chaffee, Ellen E. and Esther M. Greisheimer. *Basic Physiology and Anatomy*. 4th ed. Philadelphia: J. B. Lippincott Co., 1974.

Crouch, James E. and J. Robert McClintic. *Human Anatomy and Physiology*. New York: John Wiley and Sons, 1971.

Grant, J. C. Boileau. *An Atlas of Anatomy*. 6th ed. Baltimore: Williams and Wilkins Co., 1972.

Guyton, Arthur C., *Basic Human Physiology*. Philadelphia: W. B. Saunders Co., 1971.

Jacob, Stanley W. and Clarice Ashworth Francone. *Structure and Function in Man*. 3rd ed. Philadelphia: W. B. Saunders Co., 1974.

Lockhart, Robert D., et al. *Anatomy of the Human Body*. Philadelphia: J. B. Lippincott Co., 1969.

McNaught, Ann B. and Robin Callander. *Illustrated Physiology*. 2nd ed. Edinburgh: E. and S. Livingston, 1970.

Scientific American, published monthly, 250 West 55th Street, New York, New York 10019.

CHM 109 GENERAL CHEMISTRY I

PLACEMENT: First Quarter

COURSE DESCRIPTION:

Study of the physical and chemical properties of substances, chemical changes, elements, compounds, gases, chemical combinations, weight and measurements, theory of metals, acids, bases, salts, solvents, solutions, and emulsions. In addition, study of carbohydrates, electrochemistry, electrolytes, and electrolysis. Industrial and agricultural applications are emphasized.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: None

SUGGESTED TEXTBOOK:

Cherim, S. M., Chemistry for Laboratory Technicians. Philadelphia:
W. B. Saunders Co., 1971.

COURSE OBJECTIVE: To give the student a beginning understanding of the practical principles of General Chemistry.

COURSE OUTLINE:

I. Scientific Mathematics
    A. Scientific notation
        1. Changing sign of exponent
        2. Rules of exponents in multiplication and division
    B. The metric system
        1. Units of length and area
        2. Conversion between units
        3. Units of volume
        4. Units of mass
    C. Temperature
        1. Fahrenheit scale
        2. Celsius scale
        3. Kelvin scale
    D. Signigicant figures
        1. Precision
        2. Accuracy
    E. Introduction to slide rule

II. Measurement

- A. Gravimetric methods
- B. Gravimetric analysis
- C. Volumetric methods - Glassware
  - 1. Flasks
  - 2. Cylinders
  - 3. Burets
  - 4. Pipets
- D. Density and specific gravity
- E. Electrical measurements and interrelationships
  - 1. Electrical units
    - a. Volt
    - b. Ampere
    - c. Ohm
    - d. Watt
  - 2. Circuit diagram
  - 3. The meter
- F. Graphs - construction and analysis

III. Matter and Energy

- A. Components of matter
  - 1. Atom
  - 2. Law of conservation of matter
- B. Units of matter
  - 1. Element
  - 2. Compound
  - 3. Molecule
  - 4. Mixture
- C. Physical states of matter
  - 1. Solid
  - 2. Liquid
  - 3. Gas
- D. Interinversion of physical states
  - 1. Evaporation
  - 2. Condensation
  - 3. Freezing
  - 4. Melting
  - 5. Sublimation
- E. Energy
  - 1. Types
    - a. Kinetic energy
    - b. Potential energy
  - 2. Interinversion of energy

IV. Atomic Structure

- A. Components of the atom

        1. The nucleus
            a. Neutrons
            b. Protrons
        2. The electron
    - B. Concepts of energy levels
        1. Ground state
        2. Valence
        3. Valence shell
    - C. Atomic number
    - D. Atomic weight

V. Fundamentals of Chemistry

- A. Periodic chart
- B. Periodic law
- C. Nature of the chemical bond
    1. Imic bond
    2. Covalent bond
    3. Metallic bond
    4. Network bond
    5. Hydrogen bond
- D. Formulas and nomenclature
    1. Special nomenclature of acid
    2. Special nomenclature used for nomenclature compounds
- E. The mole concept
    1. Avogadro's number
    2. Molar volume
- F. Introduction to stoichiometry
- G. Empherical formulas
- H. Equations
- I. Stoichiometric equations

ENG 101 GRAMMAR*

PLACEMENT: First Quarter

COURSE DESCRIPTION:

Designed to aid the student in the improvement of self-expression through writing. Emphasis is on grammar, diction, sentence structure, punctuation and spelling. It is intended to stimulate students in applying the basic principles of English grammar in their day-to-day situations.

COURSE HOURS PER WEEK: Class 3; Lab 0; Clinical 0

QUARTER HOURS CREDIT: 3

MAJOR DIVISIONS OF COURSE CONTENT:

I. Parts of Speech

II. Correct Word Choice

III. Sentence Structure

IV. Punctuation

V. Paragraphs and Topic Sentences

SUGGESTED TEXTBOOKS:

Aurner, Robert R. and Paul S. Burtners. Practical English for Colleges. 4th ed. Chicago: South-Western Publishing Co., 1969.

Graham, Sheila Y., Harbrace College Workbook. Form 7A and 7B. New York: Harcourt Brace Jovanovich, 1973.

Hodges, John C. and Mary E. Whitten. Harbrace College Handbook. 7th ed. New York: Harcourt Brace Jovanovich, 1972.

Perrin, Porter G. and George H. Smith. Handbook of Current English. Glenview, Illinois: Scott, Foresman and Co., 1968.

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*This is an abstract of the English Grammar syllabus. For a complete copy, write to Program Development Division, Department of Community Colleges, Education Building, Raleigh, NC 27611. For a copy of English 100 Oral Communication, write to the English Department, Forsyth Technical Institute, 2100 Silas Creek Parkway, Winston-Salem, NC, 27103

MAT 124 MATHEMATICS I

PLACEMENT: First Quarter

COURSE DESCRIPTION:

The first of a series of two courses designed to develop and maintain a high level of proficiency in basic mathematical skills and algebra fundamentals. Topics covered are: Fundamental facts about whole numbers, fractions, percents, slide rule, expanded notation, positive and negative numbers, functions and graphs, trigonometric functions, and linear equations.

COURSE HOURS PER WEEK: Class 3; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 3

PREREQUISITE: Satisfactory score on the mathematics placement test or passing grade in Pre-Technical Mathematics

SUGGESTED TEXTBOOK:

Washington, Allyn J., Basic Technical Mathematics with Calculus. Latest ed. Menlo Park, California: Cummings Publishing Company.

CURRENT EQUIPMENT: A professional grade slide rule is required.

COURSE OBJECTIVES: To develop an appreciation for and understanding of basic algebra and trigonometry; to help technical students learn how to use the techniques of mathematics as a professional tool; to aid the student in gaining some understanding of the power and utility of mathematics.

COURSE OUTLINE:

Unit Objective: To emphasize and refresh the students' memories on the fundamental concepts and operations of arithmetic and basic algebra which will be essential to the successful completion of MAT 113 and MAT 114. Approximate time allotment: 6 hours.

Content	Learning Experiences
I. Fundamental Concepts and Operations	

I. Fundamental Concepts and Operations

- A. Fundamental concepts
  - 1. Whole numbers, fractions, decimals, percents
  - 2. Fundamentals of algebra
  - 3. Exponents

4. Addition, subtraction, multiplication and division of algebraic expressions
5. Simple equations
6. Applications

Unit Objectives: To assure that the student can adequately manipulate the slide rule to solve multi-step problems involving multiplication, division, inverses, squares, cubes, square roots and cube roots. Approximate time allotment: 6 hours.

Content	Learning Experiences
II. Slide Rule A. The C and D scales 1. Multiplication 2. Division 3. Finding the decimal 4. Chain operations B. Inverses using the Ci or Di scale C. The A and B scales 1. Squaring 2. Square roots D. The K scale 1. Cubing 2. Cube roots E. The L scale F. The S, T, and ST scales G. Applications	At the conclusion of this section the student will exhibit a level of accuracy in computations on the slide rule

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Unit Objectives: To teach the student the many different types of functions, some of the methods of solving functions, including the graphical method, and to illustrate the relationships between two or more variables and constants. Approximate time allotment: 5 hours.

Content	Learning Experiences
III. Functions and Graphs A. Functions B. Rectangular coordinates C. (Plot) graphs of functions D. Applications	At the conclusion of this section, given f (x) and g (x) the student will plot points to construct approximation to graphs of f (x) and [f + g] (x)

Unit Objectives: To teach the students to solve simultaneously two equations in two unknowns by graphical methods and to solve "n" equations in "n" unknowns algebraically and by the method of determinants. Approximate time allotment: 5 hours.

Content	Learning Experiences
IV. Linear Equations and Determinants A. Solving by graph B. Solving by substitution C. Expansion by minors D. Applications	At the conclusion of this section, the student will solve systems of simultaneous equations in 2, 3 or more unknowns by any of the methods A, B, or C.

Unit Objectives: To review some of the basic definitions and fundamentals of plane geometry and to introduce the student to the six trigonometric functions and how to apply them to the solution of right triangles. Approximate time allotment: 6 hours.

Content	Learning Experiences
V. The Trigonometric Functions A. Angular measure 1. Radians 2. Degrees 3. Conversion of one to the other B. Define sine, cosine, and tangent 1. General behavior 2. Special angles C. The right triangle D. Applications	At the conclusion of this section, the student will: 1. Use appropriate formula to convert radian measure to angular measure or vice versa 2. Given two parts of a right triangle, use sine, cosine, or tangent to compute the remaining parts 3. Use linear interpolation to compute "in between" values from the trig tables

BIO 125 MEDICAL TECHNOLOGY I

PLACEMENT: First Quarter

COURSE DESCRIPTION:

The first of a series of two courses which include terms related to all areas of medical science, hospital service and paramedical specialties. Terms introduced paralell the topics covered in Anatomy and Physiology I.

COURSE HOURS PER WEEK: Class 1; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 1

PREREQUISITE: None

SUGGESTED TEXTBOOK:

Dorland's Illustrated Medical Dictionary. 25th ed. Philadelphia: W. B. Saunders Co., 1974.

COURSE OBJECTIVES: The student will be able to:

1. Spell correctly selected medical words related to medical fields and the integumentary, skeletal, muscular, nervous systems and hematology.
2. Pronounce correctly selected medical words related to medical fields and the integumentary, skeletal, muscular, nervous systems and hematology.
3. Define selected medical words related to medical fields and the integumentary, skeletal, muscular, nervous systems and hematology.
4. Explain basic concepts concerned with the formation of medical terms.
5. Demonstrate ability to use medical dictionaries.

EVALUATION: Weekly quizzes, mid-term and final exams

COURSE OUTLINE:

Unit Objective: Develop skill in using medical dictionaries. Approximate time allotment: 1 hour.

Content	Learning Experiences
I. The Dictionary	
A. Use of the dictionary	Dictionary drills
B. Pronunciation of medical terms	
C. Formation of pleural forms	
D. Origin of medical terms	

Unit Objective: Develop an analytical approach to learning medical terms. Approximate time allotment: 1 hour.

Content	Learning Experiences
II. Prefixes and Suffixes	Word lists
A. Prefixes	
1. Definitions	
2. Examples	
a. Location	
b. Number	
c. Position	
B. Suffixes	
1. Definitions	
2. Examples	
a. Diagnostic	
b. Symptomatic	
c. Operative	

Unit Objectives: (1) Define basic terms related to the body systems; (2) Spell basic terms related to the body systems; and (3) Pronounce basic terms related to the body systems.

Content	Learning Experiences
III. Terminology of the Body	Word lists
A. Terminology of the integumentary system	
1. Origin of terms	
2. Symptomatic terms	
3. Diagnostic terms	
4. Operative terms	
B. Terminology of the skeletal system	
1. Origin of terms	
2. Symptomatic terms	
3. Diagnostic terms	
4. Operative terms	
C. Terminology of the muscular system	
1. Origin of terms	
2. Symptomatic terms	
3. Diagnostic terms	
4. Operative terms	

D. Terminology of the nervous system
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms

E. Terminology related to psychiatric disorders
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms

F. Terminology related to hematology
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms

NMT 101 NUCLEAR MEDICINE TECHNOLOGY I

PLACEMENT: First Quarter

COURSE DESCRIPTION:

An orientation to the field of nuclear medicine technology. Elementary patient care procedures and professional ethics are emphasized.

COURSE HOURS PER WEEK: Class 1; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 1

PREREQUISITE: None

SUGGESTED TEXTBOOK: None. Method of instruction includes reports of assigned reading and guided discussion.

COURSE OBJECTIVES: The student will be able to:

1. Demonstrate proper patient care.

2. Develop professional ethics.

COURSE OUTLINE:

I. Orientation to Nuclear Medicine Technology

    A. Program of study
        1. General curriculum
        2. Nuclear medicine core curriculum
    B. The field of nuclear medicine technology
        1. Job opportunities
        2. Advanced training
        3. Degree options
        4. Professional organizations
    C. Brief history of medicine and nuclear medicine - discovery of radioactivity
        1. Natural
        2. Artificial
    D. Ethics and professional appearance
        1. Definition
        2. Relationship of technologist with:
            a. Director, nuclear medicine
            b. Medical staff
            c. Co-workers
                (1) Senior staff technologists
                (2) Office staff
                (3) Other hospital personnel
            d. Patients and families

    3. Professional bearing
        a. Hygiene
        b. Uniforms
        c. Care of department and equipment
    4. Medical legal aspects of technology

II. Introduction to Patient Care

- A. Emergency procedures in nuclear medicine
    1. Crash cart
    2. Emergency codes
- B. Proper methods of transporting patients
- C. Patients that need special care
    1. Patients with intravenous fluids
    2. Patients with nasogastric tubes
    3. Patients with chest tubes
    4. Coronary care patients
    5. Patients with tracheostomy

SECOND QUARTER

BIO 124 ANATOMY AND PHYSIOLOGY II

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

This course is a continuation of the study of the normal structure and function of man. Emphasis is on the circulatory, lymphatic, respiratory, digestive, urinary, reproductive and endocrine systems and fluid and electrolyte balance. Laboratory experiences include small animal dissections and physiology experiments to augment the students' understanding of body structure and function.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: BIO 123 Anatomy and Physiology I

SUGGESTED TEXTBOOK:

Anthony, Catherine P. and Norma J. Kolthoff. Textbook of Anatomy and Physiology. 8th ed. St. Louis: The C. V. Mosby Co., 1971.

Laboratory directions prepared by instructor.

COURSE OBJECTIVES: The student will be able to:

1. Identify structures and functions of the circulatory, lymphatic, respiratory, digestive, urinary, reproductive, and endocrine systems.
2. Develop an understanding of the roles played by the systems of the body in maintaining homeostasis.
3. Develop knowledge of hormone control mechanisms which are necessary for normal body development and function.

EVALUATION: Weekly quizzes, mid-term and final exams, laboratory quizzes.

COURSE OUTLINE:

Unit Objective: Comprehend the range of metabolic functions which maintain homeostasis. Approximate time allotment: Class 25 hrs.; Lab 16 hrs.

Content	Learning Experiences
I. Regulation of the Internal Environment	
A. Cardiovascular system	
1. Heart	Dissection of fresh beef heart

a. Anatomy (1) Covering (2) Chambers and valve (3) Layers (4) Conducting system	Demonstrations: Heart action in frog frog Variation of heart rate with temperature Circulation in frog capillaries
b. Physiology (1) Cardiac output (2) Cardiac cycle (3) Heart sounds (4) Properties of myocardial tissue (5) Neural regulations	Physiological exercises: 1. Variation in heart rate and blood pressure with exercise 2. Harvard step test Film: Functions of the Heart (Smith, Kline, and French)
2. Blood vessels a. Anatomy b. Circulation (1) Fetal (2) Portal (3) Systemic (4) Pulmonary	Dissection of fetal pig: heart, arteries, and veins Demonstration: Embalmed cat
3. Physiology of circulation a. Blood pressure b. Pulse c. Regulation (1) Cardiac reflexes (2) Vasomotor reflexes (3) Chemical control	
B. Lymphatic system 1. Anatomy a. Capillaries b. Vessels c. Ducts d. Nodes 2. Physiology a. Formation of lymph and interstitial fluid b. Circulation 3. Related lymphoid organs and tissue a. Spleen b. Tonsils c. Thymus	
C. Respiratory system 1. Anatomy a. Respiratory passages b. Lungs	Dissection of fetal pig: respiratory system Demonstration: Ciliary action in frog's pharynx
2. Physiology a. Mechanics of breathing (1) Pressure changes (2) Volume changes	Experiment: Hyperventilation

b. Exchange and transportation of gases c. Control of breathing (1) Neural (2) Chemical (3) Voluntary	Visit to the Medical School Anatomy Lab to view cadaver for: neck and thoracic structure
D. Digestive system 1. Anatomy and histology of the tract 2. Physiology of digestion a. Mouth b. Stomach c. Small intestines d. Large intestines 3. Accessory structures a. Liver b. Gall bladder c. Pancreas 4. Absorption 5. Metabolism a. Basal rate b. Carbohydrate metabolism c. Protein metabolism d. Fat metabolism	Dissection of fetal pig: Digestive system Experiment: Action of ptylin on starch Demonstration: Histology of each digestive organ
E. Urinary system - gross anatomy 1. Kidney 2. Ureters 3. Urinary bladder 4. Urethra	Dissection of fetal pig: urinary system Fresh pork kidney Urinalysis
F. Fluid and electrolyte balance 1. Fluid compartments 2. Regulation of acid-bace balance a. Blood buffers (1) Bicarbonate-carbonic acid (2) Phosphate (3) Hemoglobin-oxyhemoglobin (4) Protein b. Respiratory control c. Urinary tubule control	
G. Body temperature A. Heat production B. Heat loss C. Neural control	

Unit Objective: Understand the reproductive process as it affects both parents and newly-created life. Approximate time allotment: Class 5 hrs; Lab 5 hrs.

Content	Learning Experiences
II. Genetic Continuity of Life A. Reproductive system 1. Male reproductive system a. Anatomy	Visit to Medical School Anatomy Lab to view cadaver: abdominal pelvic structures
b. Histology of testes c. Endocrinology 2. Female reproductive system a. Anatomy of external and internal organs b. Endocrinology c. Menstrual cycle d. Pregnancy	Histology of ovary, pituitary and testes Dissection of fetal pig: male and female reproductive system Demonstrations: 1. Pregnant animals 2. Human female reproductive tract 3. Human placenta 4. Pregnancy test
B. Embryology 1. Fertilization and cleavage 2. Implantation 3. Formation of fetal membrane	Demonstration: Living chick embryo
C. Genetics 1. Maturation of germ cells 2. Simple Medelian ratios	Single-trait genetics problems Human chromosome study

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Unit Objective: Understand the slow but pervasive influence of the endocrine glands. Approximate time allotment: Class 3 hrs.; Lab 1 hr.

Content	Learning Experiences
III. Integration by Endocrine Control	Histology of endocrine glands
A. Mechanics of hormone action	
B. Endocrine glands 1. Anatomy 2. Hormones produced 3. Hormonal actions 4. Abnormalities	

FACILITIES FOR TEACHING:

1. Classrooms
2. Laboratory

EQUIPMENT FOR TEACHING:

1. Microscopes
2. Skeletons, mounted and disarticulated
3. Prepared slides
4. Human torso and other models and charts
5. Movie, slide and filmstrip projectors
6. Films, slides and filmstrips

MATERIALS:

1. Human cadaver dissected especially for this course
2. Preserved animal specimens
3. Preserved human organs
4. Fresh specimens from slaughterhouse
5. Live frogs

REFERENCES:

Chaffee, Ellen E. and Esther M. Greisheimer. Basic Physiology and Anatomy. 4th ed. Philadelphia: J. B. Lippincott Co., 1974.

Bloom, William and Fawcett, Don W., Textbook of Histology. 9th ed. Philadelphia: W. B. Saunders Co., 1968.

Crouch, James E. and J. Robert McClintic. Human Anatomy and Physiology. New York: John Wiley and Sons, 1971.

Grant, J. C. Boileau. An Atlas of Anatomy. 6th ed. Baltimore: Williams and Wilkins Co., 1972.

Guyton, Arthur C., Basic Human Physiology. Philadelphia: W. B. Saunders Co., 1971.

Jacob, Stanley W. and Clarice Ashworth Francone. Structure and Function in Man. 3rd ed. Philadelphia: W. B. Saunders Co., 1974.

Lockhart, Robert D., et al. Anatomy of the Human Body. Philadelphia: J. B. Lippincott Co., 1969.

McNaught, Ann B. and Robin Callander. Illustrated Physiology. 2nd ed. Edinburgh: E. and S. Livingston, 1970.

Scientific American, published monthly, 250 West 55th Street, New York, New York 10019.

ENG 102 COMPOSITION*

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

English composition is designed to aid the student in improvement of self-expression by means of practical application in business and technical writing. Emphasis is on writing sentences, paragraphs, and compositions.

COURSE HOURS PER WEEK: Class 3; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 3

PREREQUISITE: ENG 101 Grammar

MAJOR DIVISIONS OF COURSE CONTENT:

I. Using Words

II. Types of Sentences

III. Writing Sentences

IV. Writing Paragraphs

V. Types of Writing

VI. Organizing and Writing Papers

VII. Reading, Writing and Revising Expositions

SUGGESTED TEXTBOOKS:

Decker, Randall E., Patterns of Exposition. 2nd ed. Boston: Little, Brown and Co., 1972.

Hall, Donald. Writing Well. Boston: Little, Brown and Co., 1973.

Martin, Elizabeth K. and C. Jeriel Howard. Technique: Studies in Composition. San Francisco: Canfield Press, 1972.

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*This is an abstract of the English Composition syllabus. For a complete copy, write to Program Development Division, Department of Community Colleges, Education Building, Raleigh, NC 27611. For a copy of ENG 101 Introduction to Written Composition, write to the English Department, Forsyth Technical Institute, 2100 Silas Creek Parkway, Winston-Salem, NC 27103.

CHM 110 GENERAL CHEMISTRY II

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

This is a continuation of CHM 101 with an introduction to solutions, oxidation and reduction, electrochemistry, and radioactivity.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: CHM 109 General Chemistry I

SUGGESTED TEXTBOOK: Same as for CHM 101 General Chemistry I

COURSE OBJECTIVE: To give the student a beginning understanding of the practical principles of general chemistry.

COURSE OUTLINE:

I. Solutions I

   A. Solubility and miscibility
   B. Concentrations of solutions
      1. Percent solutions
      2. Molar solutions
      3. Dilution methods
      4. Normal solutions

II. Solutions II

   A. Varieties of solvents - purity
   B. Acids and bases
      1. Acid base titration
      2. Concept of pH
      3. Buffers and pH
   C. Chromatography
      1. Paper chromatography
         a. The sample
         b. Spotting
         c. Solvent
         d. Development
         e. R_f value
      2. Descending chromatography
      3. Column chromatography
         a. The column
         b. Identification

4. Thin layer chromatography (TLC)
5. Electrophoresis
6. Dialysis

III. Oxidation - Reduction

A. Redox principles reviewed
B. Oxidation number method
C. The ion-electron method or balancing ionic redox reactions
D. Redox stoichiometry
   1. Gravimetric problems
   2. Volumetric problems
   3. Redox titration

IV. Electrochemistry

A. Coulombs, faradays and the mole
   1. Coulometry
      a. Electrolysis
      b. Electrodeposition
   2. Conductimetry - conductance
B. Electrochemical cells - Le Chatelier's Principle
C. Standard electrode potentials
D. Fuel cells
E. The pH meter

V. Radioactivity

A. Radioactive isotopes
B. Types of radiation
   1. Alpha
   2. Beta
   3. Gamma
   4. X ray
C. Types of radioactive materials
   1. Natural
   2. Artificial
D. Rate of nuclear decay - classical decay equation
E. Instruments for the detection of radiation
   1. Gas detectors
   2. Crystal detectors
F. Practical applications of radioactivity
   1. ^{14}C dating
   2. Analytical chemistry of radioactivity
   3. Isotope dilution
   4. Activation analysis

MAT 125 MATHEMATICS II

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

The second of a series of two courses designed to develop and maintain proficiency in basic mathematical skills. Topics covered are: quadratic equations, exponents and radicals, logarithms, ratio and proportion, metric and apothecaries' system of measurement, and mathematics of drugs and solution.

COURSE HOURS PER WEEK: Class 3; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 3

PREREQUISITE: MAT 124 Mathematics I

SUGGESTED TEXTBOOK:

Washington, Allyn J., Basic Technical Mathematics with Calculus. Latest ed. Menlo Park, California: Cummings Publishing Company.

CURRENT EQUIPMENT: A professional grade slide rule is required.

COURSE OBJECTIVES: To give the student a further understanding of algebra and trigonometry and their applications to practical problems and technical processes; to impart a good working knowledge of common logarithms; and to develop an understanding of the mathematics of drugs and solutions.

COURSE OUTLINE:

Unit Objective: To solve an equation of the type $AX^2 + BX + C = 0$. Approximate time allotment: 3 hours.

Content	Learning Experiences
I. Quadratic Equations A. Solution by factoring B. Completing the sequence C. Quadratic formula D. Applications	At the conclusion of this section, given an equation of the type $ax^2 + bx + c = o$, the student will use any appropriate method to compute the solutions (Complex answers included.)

Unit Objective: To familiarize the students with the very important mathematical ideas of special products, factoring a composite number or algebraic expression into its primes, and performing operations with all kinds of fractions. Approximate time allotment: 3 hours.

Content	Learning Experiences
II. Factoring and Fractions A. Factoring 1. Common factors 2. $a^2 - b^2 = (a + b)(a - b)$ 3. $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$ 4. $(a + b)(c + d)$ B. Algebraic manipulations of fractions C. Equations involving fractions D. Appications	At the conclusion of this section, the student will exhibit a level of competency involving fractions and factoring

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Unit Objective: To give the student a sound foundation in and facility with the laws of and operations with all types of exponents and radicals. This easy facility is absolutely necessary for the understanding of logarithms and all higher levels of mathematics. Approximate time allotment: 3 hours.

Content	Learning Experiences
III. Exponents and Radicals A. Exponents 1. Integral 2. Rational 3. Real B. Scientific notation C. Radical forms 1. Algebraic operations 2. Rationizing denominator D. Applications	At the conclusion of this section, the student will (1) Add, multiply and divide general algebraic terms which involve exponents; and (2) Use scientific notation to make computations involving very large and very small numbers

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Unit Objective: To develop the use of logarithms as applied to multiplication, division, raising to a power, and extracting a root of arithmetical numbers. Approximate time allotment: 5 hours.

Content	Learning Experiences
IV. Logarithms A. Definition of logarithms	At the conclusion of this section the student will multiply and divide using base 10 logarithms and linear interpolation

B. Logs to the base 10
  1. Characteristic
  2. Mantissa

C. Computation by logarithms
  1. Multiply
  2. Divide
  3. To find the power of a number by logarithms
  4. To find the root of a number by logarithms

D. Applications

Unit Objective: To understand the relationship between a ratio and a proportion and how they are used in problem solving. Approximate time allotment: 3 hours.

Content

V. Ratio and Proportion

A. Definition of ratio
B. Definition of proportion
  1. Extremes
  2. Means
C. Solving problems by proportions
D. Applications

Learning Experiences

At the conclusion of this section, the student will (1) Express ratios and proportions; and (2) Use proportions to solve problems.

Unit Objective: To familiarize the student with the metric system, and be able to convert from the English system to the metric and from the metric to the English system of measurement. Approx. time allot.: 3 hrs.

Content

VI. The Metric System

A. Terms used in the metric system
B. Metric system tables
  1. Length
  2. Surface area
  3. Volume
  4. Weight
C. Relation of units
D. Changing from English to metric and metric to English
E. Applications

Learning Experiences

At the conclusion of this section the student will perform computations involving the metric system

Unit Objective: To familiarize the student with the apothecaries' system. Approximate time allotment: 5 hours.

Content

VII. Apothecaries' System

- A. Terms used in apothecaries' system
- B. Apothecaries' system tables
  - 1. Liquid
  - 2. Weight
- C. Conversion between metric and apothecaries' system
- D. Applications

Learning Experiences

At the conclusion of this section, the student will perform computations involving the apothecaries' system

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Unit Objective: To prepare the student to calculate dosages and solutions from tablets and prepared-strength liquids. Approximate time allotment: 5 hours.

Content

VIII. Drugs and Solutions

A. Computing dosages from tablets, capsules, powders, and prepared-strength liquids using the proportion:

$$\frac{\text{Dosage Desired}}{\text{Have}} = \frac{\text{Amount Desired}}{\text{Have}}$$

B. Computing dosage from drugs manufactured in systems other than the apothecaries' and metric systems

C. Computing dosage for infants and children

D. Preparation of solutions from pure drugs, tablets and prepared-strength solutions using the proportion:

$$\frac{\text{Amount of drug}}{\text{Amount of solution}} = \frac{\text{\% of solution}}{\text{\% of stock solution solution}}$$

Learning Experiences

At the conclusion of this section, the student will exhibit a level of competency in calculating dosages and solutions from tablets and liquids

REFERENCE:

Saxton and Walter. Programmed Instruction in Arithmetic, Dosages, and Solutions. 2nd ed. St. Louis: The C. V. Mosby Co., 1970.

BIO 126 MEDICAL TERMINOLOGY II

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

The second of a series of two courses in which terms related to all areas of medical science, hospital service, and paramedical specialties are introduced. Terms parallel the topics covered in Anatomy and Physiology II.

COURSE HOURS PER WEEK: Class 1; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 1

PREREQUISITE: BIO 125 Medical Terminology I

SUGGESTED TEXTBOOK:

Dorland's Illustrated Medical Dictionary. 25th ed. Philadelphia: W. B. Saunders Co., 1974.

COURSE OBJECTIVES: The student will be able to:

1. Spell correctly selected medical terms related to the cardiovascular, respiratory, digestive, excretory, reproductive and endocrine systems.
2. Pronounce correctly selected medical terms related to the cardiovascular, respiratory, digestive, excretory, reproductive and endocrine systems.
3. Define selected medical terms related to the cardiovascular, respiratory, digestive, excretory, reproductive and endocrine systems.
4. Interpret unfamiliar vocabulary with some degree of accuracy.

EVALUATION: Weekly quizzes, mid-term and final exams.

COURSE OUTLINE:

Unit Objectives: (1) Define basic terms related to the cardiovasuclar system; (2) Spell basic terms related to the cardiovascular systems; and (3) Pronounce basic terms related to the cardiovascular system. Time allotment: 2 hours.

Content	Learning Experiences
I. Cardiovasuclar System	(Teacher may write in)
A. Heart	
1. Origin of terms	

    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms
B. Blood vessel
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms
C. Lymphatic system
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms

Unit Objectives: (1) Define basic terms related to the respiratory system; (2) Spell basic terms related to the respiratory system; and (3) Pronounce basic terms related to the respiratory system. Time allotment: 1 hour.

Content	Learning Experiences
II. Respiratory System	(Teacher may write in)

A. Origin of terms
B. Symptomatic terms
C. Diagnostic terms
D. Operative terms

Unit Objectives: (1) Define basic terms related to the digestive system; (2) Spell basic terms related to the digestive system; and (3) Pronounce basic terms related to the digestive system. Time allotment: 2 hours.

Content	Learning Experiences
III. Digestive System	(Teacher may write in)

A. Digestive tract
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms
B. Accessory digestive organs
    1. Origin of terms
    2. Symptomatic terms
    3. Diagnostic terms
    4. Operative terms

Unit Objectives: (1) Define basic terms related to the excretory system; (2) Spell basic terms related to the excretory system; and (3) Pronounce basic terms related to the excretory system. Time allotment: 1 hour.

Content	Learning Experiences
IV. Excretory System	(Teacher may write in)
A. Origin of terms	
B. Symptomatic terms	
C. Diagnostic terms	
D. Operative terms	

Unit Objectives: (1) Define basic terms related to the reproductive system; (2) Spell basic terms related to the reproductive system; and (3) Pronounce basic terms related to the reproductive system. Time allotment: 1 hour.

Content	Learning Experiences
V. Reproductive System	(Teacher may write in)
A. Origin of terms	
B. Symptomatic terms	
C. Diagnostic terms	
D. Operative terms	

Unit Objectives: (1) Define basic terms related to embryology; (2) Spell basic terms related to embryology; and (3) Pronounce basic terms related to embryology. Time allotment: 1 hour.

Content	Learning Experiences
VI. Embryology	(Teacher may write in)
A. Origin of terms	
B. Symptomatic terms	
C. Diagnostic terms	
D. Operative terms	

Unit Objectives: (1) Define basic terms related to the endocrine system; (2) Spell basic terms related to the endocrine system; and (3) Pronounce basic terms related to the endocrine system. Time allotment: 1 hour.

Content	Learning Experiences
VII. Endocrine System	(Teacher may write in)
A. Origin of terms	
B. Symptomatic terms	
C. Diagnostic terms	
D. Operative terms	

PHY 114 PHYSICS

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

An introductory physics course intended for those who have not had previous study in the field. Basic concepts in kinematics, heat, light, sound, electricity and atomic physics are stressed.

COURSE HOURS PER WEEK: Class 3; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 3

PREREQUISITE: MAT 124 Mathematics I

SUGGESTED TEXTBOOK:

Williams, Metcalfe, Trinklein and Lefler. Modern Physics. New York: Holt, Rinehart, and Winston, Inc., 1968.

COURSE OBJECTIVE: To give the student a practical working knowledge of force, motion, work, energy, power, hydrostatics, and direct-current electricity applicable to radiologic physics.

COURSE OUTLINE:

I. Matter and Energy
    A. Definition of physics
    B. Matter
        1. Concept
        2. Properties
            a. Chemical
            b. Physical
        3. Mass and weight
        4. Inertia
        5. Law of conservation
    C. Energy
        1. Concept
        2. Kinds of energy
            a. Kinetic
                (1) Electrical
                (2) Heat
                (3) Sound
                (4) Light
                (5) Mechanical
            b. Potential
        3. Law of conservation
    D. Matter-energy relations

II. Terms of Measurement

- A. Expressing relations
  - 1. Proportionalities
  - 2. Equations
  - 3. Tables
  - 4. Graphs
- B. Coherent system of units
  - 1. Indefinables of mechanics
    - a. Length
    - b. Mass
    - c. Time
  - 2. Derivation of additional units using indefinables
  - 3. Standards and symbols for units
  - 4. Meter-kilogram-second system
  - 5. Centimeter-gram-second system
  - 6. English system
- C. Graphical representation of forces
  - 1. Definition of force
  - 2. Definition of scalar
  - 3. Definition of vector
  - 4. Components of a vector
  - 5. Resultant or vector sum
    - a. Polygon method
    - b. Parallelogram method

III. Friction

- A. Definition
- B. General principles
- C. Measurement of frictional force - co-efficient of friction
- D. Altering the amount

IV. Equilibrium

- A. Conditions
  - 1. Translational
  - 2. Rotational
- B. Moment of a force
- C. Resultant of parallel forces
- D. Center of gravity

V. Rectillinear Motion

- A. Speed
- B. Velocity
  - 1. Definition
  - 2. Average
  - 3. Uniform
  - 4. Variable
  - 5. Vector resultant

C. Acceleration
    1. Definition
    2. Uniform
    3. Variable
    4. Freely falling bodies
D. Newton's laws of motion
    1. Inertia and mass
    2. Law of acceleration
    3. Law of interaction
    4. Momentum
        a. Definition
        b. Impulse
        c. Reaction of principle
        d. Law of conservation
E. Gravitation
    1. Nature of gravitation
    2. Law of universal gravitation
    3. Gravitational constant
    4. Relation of gravity and weight

VI. Curvilinear Motion

A. Circular motion
    1. Projectile motion
    2. Uniform circular motion
        a. Centripetal effects
        b. Centrifugal effects
B. Simple harmonic motion
    1. Periodic motion
    2. Relationship between circular and simple harmonic motions
    3. Pendulum motion

VII. Work, Power and Energy

A. Work
    1. Definition
    2. Units of work
        a. Metric
        b. English
B. Energy
    1. Potential
        a. Gravitational
        b. Elastic
    2. Measurement of energy
        a. Metric
        b. English
    3. Conservation of energy
    4. Energy and its transformations
C. Power
    1. Definition
    2. Units of power

VIII. Thermal Effects

- A. Temperature
  - 1. Definition
  - 2. Measurement
  - 3. Scales
- B. Heat
  - 1. Definition
  - 2. Sources
- C. Thermal expansion - solids
  - 1. Coefficient of linear expansion
  - 2. Liquids
  - 3. Gases
  - 4. Absormal expansion of water
- D. Heat measurement
  - 1. Units
    - a. Kilocalorie
    - b. Calorie
  - 2. Heat capacity
  - 3. Specific heat
  - 4. Law of heat exchange
- E. Heat transfer
  - 1. Conduction
  - 2. Convection
  - 3. Radiation

IX. Change of State

- A. States of matter
  - 1. Solid
  - 2. Liquid
  - 3. Gas
- B. Fusion
  - 1. Heat of fusion of ice
  - 2. Melting point
  - 3. Solidification
  - 4. Freezing point - effect of pressure
- C. Vaporization
  - 1. Evaporation
  - 2. Sublimation
  - 3. Condensation
  - 4. Boiling
    - a. Boiling point
    - b. Effect of pressure
  - 5. Heat of vaporization of water

X. Kinetic Theory of Matter

- A. Theory definition
- B. Van der Waals forces

- C. Solids
    - 1. Nature
        - a. Crystalline
        - b. Amorphous
    - 2. Properties
        - a. Diffusion
        - b. Cohesion
        - c. Adhesion
        - d. Tensile strength
        - e. Ductility
        - f. Malleability
        - g. Elasticity
            - (1) Stress
            - (2) Strain
            - (3) Hooke's law
- D. Liquids
    - 1. Nature
    - 2. Properties
        - a. Diffusion
        - b. Cohesion
        - c. Adhesion
        - d. Surface tension
        - e. Capillarity
- E. Gases
    - 1. Nature
    - 2. Properties
        - a. Expansion
        - b. Pressure
        - c. Density
    - 3. Ideal gas
- F. Hydrostatics
    - 1. Definition
    - 2. Pressure in a fluid - Pascal's law
    - 3. Archimedes principle
        - a. Buoyant force
        - b. Specific gravity
- G. Hydrodynamics
    - 1. Streamline flow
    - 2. Bernoulli's equation - applications

XI. Atomic Structure

- A. Molecule
- B. Atom
    - 1. Chemical element
    - 2. Atomic mass
    - 3. Mass number
- C. Atomic theory
- D. Subatomic particles

- E. Electron
    - 1. Mass
    - 2. Charge
    - 3. Size
    - 4. Wave properties
    - 5. Discovery
    - 6. Motion
        - a. Orbital
        - b. Shell
        - c. Energy levels
- F. Nucleus
    - 1. Discovery
    - 2. Size
    - 3. Mass
    - 4. Proton
        - a. Anode
        - b. Atomic number
    - 5. Neutron
- G. Isotopes
- H. Nuclear binding

XII. Electrostatics

- A. Electrification
- B. Kinds of electric charge
    - 1. Positive
    - 2. Negative
    - 3. Law of electrostatics
- C. Electroscope
- D. Conductors and insulators
- E. Transferring electrostatic charge
    - 1. Separation
    - 2. Conduction
    - 3. Induction
- F. Forces between charges
    - 1. Coulomb
    - 2. Coulomb's law
- G. Potential difference
    - 1. Definition
    - 2. Ground
    - 3. Units

NMT 102 NUCLEAR MEDICINE TECHNOLOGY II

PLACEMENT: Second Quarter

COURSE DESCRIPTION:

An introduction to the radiopharmaceuticals and instruments used in nuclear medicine. Radiation safety procedures will be discussed.

COURSE HOURS PER WEEK: Class 1; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 1

PREREQUISITE: NMT 101 Nuclear Medicine Technology I

SUGGESTED TEXTBOOK: None. Method of instruction includes reports of assigned reading and guided discussion.

COURSE OUTLINE:

I. Orientation to Radiopharmaceuticals and Instrumentation

    A. Introduction
    B. Radiopharmaceuticals
        1. Radionuclide
        2. Nuclide generators
        3. Selection of a radiopharmaceutical
    C. Instrumentation
        1. Scintillation counters
        2. Stationary probes
        3. Well counters
        4. Scanners
        5. Cameras

II. Radiation Protection

    A. Radiation protection standards
        1. Personnel monitoring
        2. Protection devices
            a. Built-in shielding
            b. Accessories
        3. Surveys of department
            a. Wipe tests
            b. Instruments used for doing surveys

THIRD QUARTER

CHM 202 ORGANIC CHEMISTRY

PLACEMENT: Third Quarter

COURSE DESCRIPTION:

A study of nomenclature, variety, usefulness, and most significant properties of selected organic compounds.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: CHM 110 General Chemistry II

SUGGESTED TEXTBOOK:

Neal, Leslie A., Chemistry and Biochemistry: A Comprehensive Introduction. New York: McGraw-Hill Book Co., 1971.

COURSE OUTLINE:

I. Carbon

    A. Electron distribution of carbon
        1. Most stable electronic configuration
        2. Sp^3 hybrid
    B. The carbon-to-carbon bond
        1. Single bond
        2. Double bond
        3. Dienes
        4. Triple bond
    C. Combination of elements - compounds
    D. Optical isomers
    E. Properties of optical isomers

II. Hydrocarbons

    A. Alkanes
    B. Classification of carbon and hydrogen atoms
    C. Nomenclature
    D. Reactions of hydrocarbons
        1. Complete oxidation
        2. Substitution
        3. Alkyl halides

- E. Alkenes
    - 1. Geometric isomers
    - 2. Nomenclature
    - 3. Preparation
    - 4. Reactions of alkenes
        - a. Hydrogenation
        - b. Hydration
        - c. Halogenation
        - d. Oxidation
- F. Polyenes
- G. Alkyne - reactions - hydration
- H. Aromatic compounds
    - 1. Nomenclature
    - 2. Reactions - substitution
- I. Polymers

III. Alcohols

- A. Classification
- B. Nomenclature
- C. Formation - fermentation
- D. Reactions
    - 1. Oxidation
    - 2. Dickromate oxidation
    - 3. Catalytic oxidation
    - 4. Replacement of OH by halogens
    - 5. Dehydration
        - a. Dehydration to form ethers
        - b. Dehydration to form alkenes
        - c. Mechanism of dehydration with H_2SO_4
        - d. Comparison of dehydration with substitution
    - 6. Replacement of H in the OH group
    - 7. Some biological dehydrogenation, hydration and dehydration reactions
- E. Thioalcohols

IV. Aldehydes and Ketones

- A. Reaction of the carbonyl group
    - 1. Addition of water
    - 2. Reaction with alcohols
    - 3. Addition of HCN
    - 4. Reaction with NH_4CN
    - 5. Oxidation
    - 6. Reduction
- B. Tests for the carbonyl group
    - 1. Cupric Ion
    - 2. Benedict's reagent
- C. Summary of reactions

V. Carbohylic Acids

- A. Nomenclature
- B. Fatty acids
- C. Polycarboxylic acids
- D. Reactions
  - 1. Ionization
  - 2. Substituted acids
  - 3. Neutralization
  - 4. Esterification
  - 5. Reactivity of acids and alcohols
  - 6. Mixed esters
  - 7. Saponification
- E. Aromatic acids and sulfhydryls
  - 1. Phenols
  - 2. Aromatic carboxylic acids
  - 3. Sulfhydryl compounds
  - 4. Oxidation

VI. Amines, Amides, and Heterocyclic Nitrogen Compounds

- A. Classification of amines
  - 1. Structure
  - 2. Nomenclature
  - 3. Preparation
  - 4. Reactions
    - a. Protonation
    - b. Nitrous acid
- B. Structure of amides
  - 1. Nomenclature
  - 2. Preparation
  - 3. Acyl chloride
  - 4. Anhydride
- C. Heterocyclic compounds
  - 1. Electron distribution
  - 2. Some common rings
  - 3. Vitamin B_6 reactions

BIO 169 FUNDAMENTALS OF DISEASE PROCESSES

PLACEMENT: Third Quarter

COURSE DESCRIPTION:

An introduction to the major processes involved in producing pathological entities and disorders in man and how such states interfere with normal physiology. This knowledge of diseases and abnormal states is correlated with the more commonly seen pathology in clinical practices. Emphasis will be placed upon the fundamental principles of microbiology, the relationship of microorganisms to disease, modes of transmission, control, and the etiological agents of infectious diseases.

COURSE HOURS PER WEEK: Class 4; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITES: BIO 123 Anatomy and Physiology I and BIO 124 Anatomy and Physiology II

SUGGESTED TEXTBOOK:

Smith, Alice L., Microbiology & Pathology. 10th ed. St. Louis: The C. V. Mosby Co., 1972.

COURSE OBJECTIVES: The student shall be able to:

1. Describe structure and function of the various microorganisms.
2. Describe means of performing various laboratory procedures and to recognize results by observation.
3. Describe major means of sterilization and disinfection.
4. Discuss means by which microorganisms spread in the environment.
5. Describe the course microorganisms take upon entry to the body and effects thereon.
6. Describe bodily means of resistance to disease: non-specific, the various types of immunity, and hypersensitivity.
7. Define terms which are applied to various pathological states and to describe bodily changes associated with each condition.
8. Recognize some pathological states in laboratory and autopsy specimens.

COURSE OUTLINE:

I. Introduction

   A. Definition of Pathology
   B. Definition of Microbiology
   C. Brief description of each field and its relation to medicine

II. Nature and Causes of Disease

   A. Hereditary disorders and congenital anomalities
      1. DNA-RNA-Protein synthesis
      2. Abnormal chromosome number
      3. Abnormalities of development
   B. Circulatory disorders
      1. Hyperemia
      2. Hemorrhage
      3. Edema
      4. Shock
      5. Thrombosis
      6. Embolism
      7. Ischemia and infarction
      8. Gangrene
      9. Fluid and acid-base balance
   C. Metabolic disorders and disturbances
      1. Atrophy
      2. Degenerations
      3. Pigmentations
      4. Calculi
      5. Necrosis
   D. Deficiency states
      1. Vitamin deficiencies
      2. Mineral deficiencies
   E. Injuries from non-living agents
   F. Neoplasms
      1. Definitions
      2. General characteristics
      3. Classification
      4. Benign tumors
      5. Malignant tumors

III. Microbiology

   A. Structure and function of microorganisms
      1. Bacteria
      2. Viruses
      3. Fungi
      4. Protozoa

B. Laboratory methods in microbiology
(These will be studied by several observation trips to the laboratory and one to the hospital laboratories.)
  1. Culture methods
  2. Stains
  3. Special media

C. Sterilization and disinfection
  1. By heat
  2. By chemical methods

D. Infection
  1. Normal flora
  2. Portal of entry and portal of exit
  3. Virulence
  4. Course of infection
  5. Spread of microorganisms

E. Disease and resistance
  1. Non-specific resistance
  2. Inflammation
  3. Immunity
    a. Natural
    b. Naturally acquired - active and passive
    c. Artificially acquired - active and passive
    d. Hypersensitivity

IV. Diseases, Including Microbial, of Major Organ Systems

A. Cardiovascular system
B. Blood
C. Lymphoid tissues
D. Respiratory system
E. Digestive system
F. Urinary system
G. Endocrine glands
H. Reproductive system
  1. Male
  2. Female
I. Nervous system
J. Bones and joints

REFERENCES:

Boyd, William. Textbook of Pathology. 8th ed. Philadelphia: Lea & Febiger, 1970.

Brinkbok, G. Charles F., Pathology for Radiographers. London: Butterworths, 1965.

Burrows, William. Textbook of Microbiology. 19th ed. Philadelphia: W. B. Saunders Co., 1971.

Fallis, Bruce D., Textbook of Pathology. New York: McGraw-Hill Book Co., 1964.

Joklik and Smith, eds. Ainsser's Microbiology. 15th ed. New York: Appleton-Century-Crofts, 1972.

Netter, Frank H., CIBA Collection of Medical Illustrations. Vols. I-V.

Robbins and Angell. Basic Pathology. Philadelphia: W. B. Saunders Co., 1971.

Scientific American, published monthly, 250 West 55th Street, New York, New York 10019.

PHY 115 PHYSICS

PLACEMENT: Third Quarter

COURSE DESCRIPTION:

A study of basic electronics and electronic instruments, their theory of operation, function, tolerances, and calibration. Principles of both service and laboratory instruments will be studied. Also, basic principles of nuclear physics are included.

COURSE HOURS PER WEEK: Class 3; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 3

PREREQUISITES: PHY 114 Physics; MAT 124 Mathematics I

SUGGESTED TEXTBOOK:

Williams, Metcalf, Trinklein, and Lefler. Modern Physics. New York: Holt, Rinehart and Winston, Inc., 1968.

COURSE OBJECTIVE: To give students an understanding of basic principles underlying the electric and electronic instruments used by health technologists. The course presents a study of the basic instruments, their theory of operation, function, tolerances, and calibration. Both service and laboratory instruments will be studied. The basic principles of nuclear physics will also be included in this course.

COURSE OUTLINE:

I. Magnetism

  A. Relation to electricity
  B. Definition
  C. Classification of magnets
    1. Natural
    2. Artificial
    3. Electromagnet
  D. Laws of magnetism
    1. Forces between magnet poles
    2. Coulomb's law
  E. Magnetic fields
    1. Lines of flux
    2. Flux density
  F. Magnetic permeability
  G. Magnetic retentivity
  H. Magnetic classification of matter
    1. Ferromagnetic

    2. Paramagnetic
    3. Diamagnetic
    4. Non-magnetic

II. Electromagnetism

  A. Oersted's Experiment
  B. Magnetic fields about current carrying conductors
    1. Ampere's rule for a straight conductor
    2. Ampere's rule for a solenoid
  C. Electromagnet
    1. Structure
    2. Uses
  D. Electromagnetic induction
    1. Definition induced
      a. Induced
      b. Current
    2. Methods of inducing emf
    3. Factors affecting induced emf magnitude
    4. Direction of induced current
      a. Left hand dynamo rule
      b. Lenz's law
  E. Self-induction
    1. Definition
    2. Inductance of a coil
  F. Mutual induction - henry

III. Electric Generators and Motors

  A. Simple A-C generator
    1. Armature
    2. Rings
    3. Field poles
    4. Brushes
    5. Action
    6. Magnitude of induced voltage and current
      a. Maximum
      b. Effective
  B. D.C. generator
    1. Parts - commutator
    2. Action
    3. Resulting current and voltage
  C. Electric motor
    1. Motor rule
    2. Back emf
    3. Types
      a. D.C. motor
      b. A.C. motor
    4. Induction
    5. Synchronous

IV. Properties of Alternating Current Circuits

- A. Inductive reactance
- B. Capcitive reactance
- C. Impedance
- D. Advantages over D.C.
    - 1. Transformer use
    - 2. Power

V. Current-measuring Devices

- A. Galvanometer - D.C.
    - 1. Parts
    - 2. Use
    - 3. Circuit effects
- B. Ammeter - D.C.
    - 1. Parts
    - 2. Use
    - 3. Circuit effects
- C. Vohmeter - D.C.
    - 1. Parts
    - 2. Use
    - 3. Circuit effects
- D. A.C. meters

VI. Production and Control of High Voltage

- A. Transformers
    - 1. Principle
        - a. Open core
        - b. Closed core
        - c. Shell-type
    - 2. Types
        - a. Step-up
        - b. Step-down
        - c. Current and voltage values
    - 3. Losses
        - a. Copper
        - b. Eddy current
        - c. Hysteresis
- B. Rheostat
    - 1. Parts and principle
    - 2. Effects on circuit
    - 3. Uses
- C. Choke coil
    - 1. Parts and principle
    - 2. Effects of circuit
    - 3. Uses

- D. Auto transformer
  - 1. Parts and principle
  - 2. Operation
  - 3. Effects on circuit
  - 4. Comparison with rheostat

VII. Rectification

- A. Definition
- B. Methods of rectification
  - 1. Self-rectification
  - 2. Valve-tube rectification
    - a. Single valve tube
    - b. Two valve tube
    - c. Four valve tubes
    - d. Factors controlling valve tube use
- C. Types of rectification
  - 1. Half-wave
  - 2. Full-wave

VIII. Wave Transfer of Energy

- A. Wave motion
  - 1. Mechanical waves
  - 2. Energy transfer
  - 3. Transverse pulse
  - 4. Longitudinal pulse
  - 5. Characteristics
    - a. Phase
    - b. Frequency
    - c. Period
    - d. Amplitude
    - e. Wave length
    - f. Velocity
  - 6. Wave interactions
    - a. Rectilinear propagatio
    - b. Reflection
    - c. Refraction
    - d. Interference
    - e. Diffraction
    - f. Interference
      - (1) Constructive
      - (2) Destructive
      - (3) Superposition principle
    - g. Polarization
    - h. Dispersion
- B. Sound waves
  - 1. Sonic spectrum
    - a. Ultrasonic
    - b. Infrasonic

   2. Production of sound
   3. Sound transmission
   4. Speed of sound
   5. Properties of sound
      a. Intensity and loudness
      b. Frequency and pitch - Doppler effect
      c. Harmonica and quality
   6. Ultra-sound uses
      a. Brain studies
      b. Nebulization

C. Light waves
   1. Particle theory
      a. Rectilinear propagation
      b. Reflection
   2. Wave theory
      a. Diffraction
      b. Interference
   3. Electromagnetic theory - spectrum
   4. Photoelectric effect - emission
   5. Quantum theory
   6. Einstein's photoelectric equation
   7. Accepted light theory

IX. Structure of Matter

A. Subdivisions of matter
   1. Definition of matter
   2. Mixture
   3. Molecule
   4. Atom
   5. Element
   6. Compound

B. Electrical nature of atomic structure
   1. Atom parts and charges
   2. Orbital elections
   3. Shell energy levels

C. Mass number

D. Atomic number

E. Other particles
   1. Position
   2. Neutrino
   3. Deuteron
   4. Alpha particle
   5. Beta particle

F. Atomic mass unit

G. Ionization
   1. Definition
   2. X-ray bombardment of matter
   3. Electron stream bombardment
   4. Radioactive breakdown

        5. Light-ray bombardment
        6. Chemical
        7. Thermionic emission
    H. Isotopes
    I. Isobar
    J. Isomer

X. Nuclear Reactions

    A. Definition
    B. Radioactive decay
        1. Atomic number valves
        2. Half-life
        3. Alpha decay
        4. Beta decay
        5. Gamma ray emission
        6. Units
            a. Radioactivity - curic
            b. Exposure to radioactivity - Roentgen
    C. Nuclear bombardment
        1. Use of protons
        2. Use of alpha particles
        3. Use of neutrons
        4. Fission
        5. Fusion
    D. Uses of nuclear energy - chain reactions - critical mass
    E. Nuclear reactor
    F. Cyclotron
    G. Radioisotopes
        1. Definition
        2. Ways produced
        3. Radiocompounds
        4. Uses

XI. Fundamental Concepts of Radiation

    A. Effects of radiation on materials
    B. Radioisotope defection
    C. Tracer
    D. Types of radiations
        1. Alpha ray
        2. Beta ray
        3. Gamma ray
        4. Effect of magnetic field on radiation particles
    E. Wave properties
    F. Photons
    G. Electron - volt
    H. Comparison of X ray and gamma rays

XII. Production and Nature of Roentgen Rays

- A. Conditions necessary for X-ray production
  - 1. Anode
  - 2. Cathode
- B. Brems radiation
  - 1. Process
  - 2. Kind of X rays produced
- C. Characteristic
  - 1. Process X rays
  - 2. Kind of X rays produced
- D. Properties of X rays
- E. X-ray spectra
- F. Direction of X-ray emission
- G. Efficiency of X-ray production
- H. Quality of X rays
  - 1. Hard X rays
  - 2. Soft X rays
  - 3. Half-Value Layer (HVL)
- I. Exposure rate factors
  - 1. Millamperage (mA)
  - 2. Kilovoltage (kV)
  - 3. Distance
  - 4. Filtration

XIII. Interaction of Radiation and Matter

- A. Secondary radiation
- B. Scattered radiation
- C. Quantum energy
  - 1. Frequency
  - 2. Wave length
- D. Unmodified scatter
  - 1. Interaction
  - 2. Results
- E. Photoelectric absorption
  - 1. Interaction
  - 2. Results
- F. Compton scattering
  - 1. Interaction
  - 2. Results
- G. Pair production
  - 1. Interaction
  - 2. Results
- H. Applications to radiology
  - 1. Diagnostic
  - 2. Therapeutic
- I. Detection of X rays
- J. Exposure - the Roentgen
- K. Absorbed dose - the rod

XIV. Thermionic Vacuum Tube

- A. General parts
  - 1. Cathode
  - 2. Anode
  - 3. Kilovoltage
- B. X-ray tube
  - 1. Glass envelope
  - 2. Filament
    - a. Kind
    - b. Molybdenum cup
    - c. Adjustments of current
    - d. Double focus tube
    - e. Booster circuit
  - 3. Anode
    - a. Stationary
    - b. Rotating
    - c. Line - focus principle
    - d. Focus size
    - e. Cooling methods
    - f. Pitting
    - g. Heat unit
  - 4. Space charge effect
    - a. Saturation point
    - b. Space charge compensation
- C. Roentgen therapy tubes
  - 1. Filament
  - 2. Anode
  - 3. Focal size
  - 4. Cooling methods
- D. Valve tube
  - 1. Filament
  - 2. Electrical resistance
  - 3. Comparison with X-ray tube
  - 4. Spinning top testing method

XV. X-ray Circuit

- A. Line voltage - compensator
- B. Primary circuit
  - 1. Main switch
  - 2. Auto transformer
  - 3. A.C. Kilovolt meter
  - 4. Timers
  - 5. X-ray exposure switch
  - 6. Circuit breakers
  - 7. Filament
    - a. Rheostat
    - b. Choke coil
    - c. Stabilizer
    - d. Ammeter
    - e. Step-down transformer

        8. Primary of X-ray transformer
    C. Secondary circuit
        1. Secondary coil of X-ray transformer
        2. Milliammeter - ballistic type
        3. Rectifier
        4. Shock proof cables
        5. X-ray tube
    D. Control panel
        1. Parts
        2. Adjustments
            a. Kilovoltage
            b. Milliamperage
            c. Time

REFERENCE:

Selman. Fundamentals of X-ray and Radium Physics. 4th ed. Springfield, Illinois: Charles C. Thomas, Publisher, 1969.

PSY 169 SOCIAL PSYCHOLOGY OF HEALTH AND ILLNESS

PLACEMENT: Third Quarter

COURSE DESCRIPTION:

A study of how culture is related to illness. Both the psychological and sociological factors will be investigated. The cultural principles attributed to illness, symptoms of illness, and situations associated with illness are studied. How illness affects family patterns and development and how psychological and sociological principles affect patient-professional, family-patient, and family-professional relationships are included.

COURSE HOURS PER WEEK: Class 4; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: None

SUGGESTED TEXTBOOK: See Course Outline, Learning Experiences

COURSE OBJECTIVES: At the completion of the course, the student will be able to:

1. Recognize and demonstrate knowledge of co-worker, helper, and student relationships.
2. Recognize and demonstrate knowledge of co-worker, helper,-and student roles.
3. Demonstrate an understanding of the patient's problems, privileges, and incentives.
4. Demonstrate effective verbal and nonverbal communication skills with patients.
5. Develop professionalism and closeness in patient relationships.
6. Recognize biological processes of aging.
7. Develop techniques for accepting and communicating with the elderly.
8. Develop a technique for discussing death with the terminal patient.
9. Employ effective communication with the terminal patient's family.

COURSE OUTLINE:

Unit Objectives: (1) To develop professionalism as a coworker; (2) To understand a student's position in a professional environment or learning situation; and (3) To demonstrate awareness of patient's perspective of student.

Content

I. The Allied Health Professional

- A. Perspective: student
  - 1. Components of professional education
    - a. Knowledge
    - b. Skills
    - c. Attitudes
  - 2. Integration of classroom and clinical education
    - a. Student anxiety
    - b. Sources of anxiety
    - c. Treatment
- B. Perspective: coworker
  - 1. Structure of clinical education
  - 2. Personality differences
    - a. Bases for problems
    - b. Resolving the problems
  - 3. Age differences
    - a. Bases for problems
    - b. Resolving the problems
- C. Persepctive: helper
  - 1. Working with people
  - 2. Characteristics of helping relationships
    - a. The social helping relationships
    - b. The therapeutic helping relationships
  - 3. Vehicles for helping
  - 4. New dimensions of helping
    - a. Professional assistant
    - b. Referral

Learning Experiences

Text: The Allied Health Professional and the Patient's Techniques of Effective Interaction, Chapters 1, 2, and 3

Handout: Terminology Sheet

Film: "Human Relations at Work"

Unit Objectives: (1) To demonstrate knowledge of patient's loss; (2) To demonstrate knowledge of patient's privileges and incentives; and (3) To demonstrate awareness of dependency relationships and their ramifications.

Content

II. The Patient

A. Problems of the patient
  1. Losses
    a. Loss of body image
    b. Losses associated with hospitalization - home and privacy
    c. Loss of independence
  2. Uncertainty about future
  3. Wider scope of problems
B. Privileges of the patient
  1. Special privileges given to the patient
  2. Some advantages of staying sick
C. Incentives for getting well
  1. Social values
  2. Individual values
  3. Discovering a meaningful value system
D. Interactions as a patient
  1. Interaction within a dependency relationship - types of dependencies
  2. Interaction with the health professionals
  3. Interaction with society
    a. Judgment by society
    b. Socioeconomic overtones
    c. Cultural - subcultural overtones

Learning Experiences

Text: The Allied Health Professional and the Patient's Techniques of Effective Interaction, Chapters 4, 5, 6, 7

Handout: Terminology Sheet

Film: "You the Patient"

Film: "You the Helper"

Unit Objectives: (1) To demonstrate ability to communicate verbally with patient; (2) To demonstrate ability to communicate nonverbally with patient; (3) To demonstrate ability to receive and comprehend nonverbal communication from patient; and (4) To demonstrate awareness of cultural and personal biases by both patient and professional.

Content

III. Determinants of Effective Interaction Between Allied Health Professional and Patient

Learning Experiences

Text: The Allied Health Professional and the Patient's Techniques of Effective Interaction, Chapters 8, 9, 10

- A. Verbal communications
    - 1. Constructs of language
    - 2. Determinants of successful verbal communication
        - a. Presentation of material
        - b. Attitudes
        - c. Voice tone and volume
        - d. Effective listening
- B. Nonverbal communications
    - 1. Pantomine and demonstration
        - a. Pantomine
        - b. Demonstration
    - 2. Metacommunications
        - a. Facial expressions
        - b. Positions, postures and gestures
        - c. Physical appearance
        - d. Touch
- C. Cultural and personal biases as determinants of effectiveness
    - 1. Cultural bias
        - a. Differing concepts of distance awareness
        - b. Differing concepts of time awareness
    - 2. Personal biases

Handout: Terminology Sheet

Unit Objectives: (1) To develop and substitute caring for casualness; (2) To develop and integrate professional and personal qualities; (3) To demonstrate ability to create professional closeness; and (4) To demonstrate setting limits for patient.

Content

IV. The Allied Health Professional - Patient Relationship

- A. Substituting casualness for caring
- B. Integrating professfonal and personal qualities
    - 1. Myth of a dichotomy
    - 2. Dispelling the myth
- C. Importance of maintaining professional distance
    - 1. Meaningful distance

Learning Experiences

Text: The Allied Health Professional and the Patient's Techniques of Effective Interaction, Chapters 11, 12, 13, 14

  2. When distance is advisable
  3. How to maintain professional distance
- D. Challenge of creating professional closeness
  1. What professional closeness is not
  2. The health professional defines limits
     a. Setting
     b. Time
  3. The health professional attends to detail
  4. Health professional reveals himself to the patient
  5. Patient is permitted to reveal himself to the health professional

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Unit Objectives: (1) To demonstrate knowledge of biological and intellectual processes of the aging; (2) To demonstrate knowledge of psychosocial processes of aging; and (3) To demonstrate knowledge of techniques for working with the elderly.

Content	Learning Experiences
V. Effective Interaction with Elderly Patient	Text: The Allied Health Professional and the Patient's Techniques of Effective Interaction, Chapters 15, 16, 17

- V. Effective Interaction with Elderly Patient
  - A. Growing older: biological and intellectual processes
    1. Some biological processes of aging
       a. Changes in skin and connective tissue
       b. Changes in musculoskelatal system
       c. Changes in the cardiovascular and respiratory systems
       d. Changes in the gastrointestinal system
       e. Changes in the genitourinary system
       f. Changes in the nervous system

    2. Some intellectual processes of aging
  B. Growing older: psychosocial processes
    1. Need for physical contact
    2. Loss of friendship and family ties
      a. Friendships
      b. Family
    3. Loss of dignity
    4. Loss of independence
    5. Role of reminiscence
  C. Working with the older patient
    1. Problem of the generation gap
    2. Assembling the parts
    3. Setting a time
    4. Establishing a routine
    5. Interacting with the senile patient
    6. Eliminating the stereotype

Unit Objectives: (1) To develop and demonstrate acceptance of patients with terminal illness; (2) To demonstrate knowledge of psychological reactions to the dying process; and (3) To demonstrate ability to communicate with patient and family.

Content

VI. Effective Interaction with the Patient Who Has a Terminal Illness

  A. The patient with a terminal illness living in the 1970's
    1. Will to live
    2. Quality of life
    3. Technology: blessing or behemoth
    4. Responsibility of life-and-death decisions
  B. Dying in the 1970's
    1. Denial of death
    2. Fears of death
      a. Fears of isolation
      b. Fears of pain
      c. Fear of the unknown
    3. Attitude toward death

Learning Experiences

Text: The Allied Health Professional and the Patient's Techniques of Effective Interaction, Chapters 18, 19, 20

Filmstrips: "Living with Dying", Parts 1 and 2

C. The process of dying
   1. Patient's reaction to knowing
   2. Family's reaction to knowing
   3. The health professional: reaction or interaction

BIO 139 TOPOGRAPHICAL ANATOMY

PLACEMENT: Third Quarter

COURSE DESCRIPTION:

A study for visualizing the patient's surface anatomy. Major emphasis is placed on learning the topographical location of internal organs, muscles, nerves and nerve plexuses, blood vessels, bony prominences, and techniques of palpation of structures not visually evident. Radiology is stressed throughout the course, since the technique defines structures not recognized by visual inspection or palpation. Living anatomy is stressed throughout the course, so that surface landmarks and palpations are constant reminders of deeper structures.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITES: BIO 123 Anatomy and Physiology I and BIO 124 Anatomy and Physiology II

SUGGESTED TEXTBOOK:

Appleton, A. B., W. J. Hamilton, and G. Simon. Surface and Radiologic Anatomy. Baltimore: Williams and Wilkins, 1971.

COURSE OBJECTIVES: The student will be able to:

1. Describe both sexual and individual differences in body structure and shall be able to describe the major body types.

2. Topographically locate and name the major bones, joints, muscles, arteries, and veins of the upper extremity.

3. Locate the major anatomic landmarks of the thorax and be able to relate these to their clinical significance(s).

4. Topographically locate and describe the major thoracic organs.

5. Name the abdominal planes and regions and topographically locate the abdominal visceral organs.

6. Identify the triangles of the neck and relate each to its anatomical significance.

7. Topographically locate the major bones, muscles and blood vessels of the face and head.

8. Describe and locate the major muscles, bony prominences, blood vessels and nerves of the lower extremity.

9. Develop a visual knowledge of the human body.

10. Develop a knowledge of the relationship of organs to other organs in the same anatomic region.

COURSE OUTLINE:

I. Introduction to Topographical Anatomy

    A. Definition and purpose
    B. Methods of study
        1. Visual inspection
        2. Palpation
        3. Auscultation
        4. Percussion
        5. Radiology
        6. Autopsy
        7. Surgery
    C. Individual variation in structure
        1. Surface contours
            a. Musculature
            b. Subcutaneous fat
            c. Bony prominences
        2. Posture
            a. Lordosis
            b. Kyphosis
            c. Scoliosis
        3. Body types
            a. Hypersthenic - broad trunk
            b. Hyposthenic - narrow trunk
        4. Sexual differences in the male and female body

II. The Upper Extremity

    A. The shoulder girdle
        1. The clavicle - collarbone
            a. Supra-clavicular fossa
            b. Infra-clavicular fossa
            c. Supra-sternal notch
        2. The scapula - shoulder blade
            a. Scapular spine
            b. The acromion and the acromion angle
            c. The coracoid process
            d. Superior and inferior angles
            e. Vertebral and axillary borders
        3. Muscles of the shoulder
            a. Deltoid
            b. Trapezius

B. The arm
  1. The anterior brachium
    a. Muscle(s) of the anterior brachium - biceps brachii
    b. Vessels and nerves of the anterior brachium
      (1) Brachial artery
      (2) Ulnar nerve
    c. The bicipital aponeurosis and the medial bicipital furrow
  2. The posterior brachium
    a. Muscles of the posterior brachium - the triceps brachii
    b. Vessels and nerves of the posterior brachium
      (1) The radial nerve
      (2) Profundii brachii artery
C. The forearm - antibrachium
  1. The antecubital fossa
  2. Bony landmarks of the forearm
    a. The olecrannon
    b. The styloid process
    c. The ulnar ridge
  3. Muscles and (or) tendons of the forearm
    a. Brachioradialis
    b. Flexor carpi radialis
    c. Palmaris longus
  4. Nerves and blood vessels of the forearm
    a. Radial nerve and artery
    b. Median nerve
    c. Ulnar nerve
    d. Cephalic, basilic, and median cubital veins
D. The wrist and hand
  1. Tendons of the wrist
  2. Surface landmarks - the anatomical "snuffbox"
  3. Palpable bones of the wrist and hand
  4. Palmar and digital creases
    a. Middle palmar creases
    b. Longitudinal palmar creases

III. The Thorax

A. Surface features and landmarks of the anterior thorax
  1. The sternal angle and its clinical significance
    a. Bifurcation of the trachea
    b. Marks rib number 2
    c. Marks top of aortic arch
  2. The epigastric fossa
  3. The intraclavicular fossa
  4. The female breast
    a. Structure
    b. Boundaries
    c. Surface features
      (1) Areola and tubercles
      (2) The axillary tail

- B. Thoracic contents
    - 1. The heart
        - a. Topographical location of heart - boundaries
        - b. Types of heart - individual variations
            - (1) Oblique
            - (2) Horizontal or transverse
            - (3) Vertical
        - c. Position of heart in relation to other visceral structures, i.e., the diaphragm
    - 2. The lungs
        - a. Anatomical structure of lungs (basic review)
            - (1) Lobes
            - (2) Hilum
            - (3) Pleura and pleural cavities
        - b. Topographical boundaries of the lungs
        - c. Mechanics of breathing (review)
            - (1) Relate to lung positions
            - (2) Relate to movement and change of position of the diaphragm
    - 3. The diaphragm - structure and topographic location
    - 4. The mediastinum and related structures
        - a. The esophagus
        - b. The trachea
        - c. Mediastinal vessels
- C. The posterior thorax - back
    - 1. Surface features and landmarks
        - a. The vertebral furrow
        - b. The vertebral column
            - (1) Palpable vertebral spines
            - (2) Topographic location and types of vertebrae
    - 2. Musculature of the back
        - a. The sacrospinalis group
        - b. The trapezius and the latissimus dorsi
    - 3. The spinal cord - structure (review) and topographical boundaries

IV. The Abdomen

- A. Surface contours and landmarks
    - 1. Linea alba
    - 2. Linea semilunaris
    - 3. The inguinal groove
    - 4. The umbilicus
    - 5. The abdominal musculature - the rectus abdominis
- B. Abdominal planes and regions
    - 1. Abdominal planes
        - a. Xiphisternal
        - b. Transpyloric
        - c. Subcostal
        - d. Supracristal

        - e. Intertubercular
        - f. Interspinous
    - 2. Abdominal regions
        - a. Left and right hypochondriae
        - b. Epigastric
        - c. Left and right lumbar
        - d. Umbilical
        - e. Left and right iliac
        - f. Hypogastric
- C. Abdominal contents
    - 1. Stomach
        - a. Structure and anatomy of (review)
        - b. Topographic location of all significant parts, i.e., the fundus, greater curvature, and pylorus
    - 2. The small intestine - topographic location of the duodenum, jejunum, and ileum
    - 3. The large intestine - topographic location of:
        - a. The caecum and appendix
        - b. The ascending colon
        - c. The transverse colon
        - d. The descending colon
        - e. The sigmoid colon
    - 4. The liver and gall bladder
        - a. Review structure
        - b. Topographic location of each
    - 5. Pancreas and spleen
        - a. Review structure of each
        - b. Topographic location of each
    - 6. Kidneys, ureters, and urinary bladder - structure and topographic location of each

V. Head and Neck

- A. Surface features and landmarks of the neck
    - 1. The supra-sternal notch
    - 2. The supra-clavicular fossa
    - 3. The larynx and hyoid bone
        - a. Thyroid cartilage
        - b. Cricoid cartilage
        - c. Greater cornu of hyoid and its clinical significance
- B. Triangles of the neck
    - 1. The posterior triangle
        - a. The occipital triangle
        - b. The subclavian triangle
    - 2. The anterior triangle
        - a. Submental triangle
        - b. Digastric triangle
        - c. Carotid triangle
        - d. Muscular triangle

- C. Muscles and blood vessels of the neck
    - 1. Muscles of the neck
        - a. The sternocleidomastoid
        - b. The omohyoid
        - c. The digastrics
        - d. The platysma
        - e. The semispinalis capitas
    - 2. Blood vessels of the neck
        - a. The carotid arteries
            - (1) Topographic location
            - (2) Point of division
        - b. Jugular veins
            - (1) Superficial location of external
            - (2) Topographic location of internal
- D. Surface features and landmarks of the head
    - 1. Bony landmarks of the head
        - a. Occipital protuberance
        - b. Parietal eminence
        - c. Temporal crest
        - d. Brow ridges and glabella
        - e. Zygoma and zyogmatic arch
        - f. Mandible and its structures
        - g. Lambda and bregma
    - 2. Sensory structures of the face and head - basic review of the eye and ear
    - 3. The brain
        - a. Review structure by using slides
        - b. Review basic lobe functions
        - c. Topographic location of all basic parts

VI. The Lower Extremity

- A. The pelvic region and associated structures
    - 1. The bony framework - visualized mainly by use of X-ray films and slides
        - a. Iliac crest and its topographical significance
        - b. Anterior and posterior superior iliac spines
    - 2. Musculature and associated features
        - a. Gluteal cleft
        - b. Gluteal fold
- B. The thigh
    - 1. Regional boundaries of thigh as opposed to leg
    - 2. Surface features of thigh
        - a. The femoral triangle and its clinical significance
        - b. The ilio-tibial band
        - c. The patellar surface and the popliteal fossa
    - 3. Muscularture of the thigh
        - a. The quadriceps femoris
        - b. The sartorius
        - c. The hamstrings - learn to palpate tendons in the popliteal fossa
        - d. The adductor group

- C. The leg
  - 1. Bony prominences of the leg
    - a. Patella
    - b. Tibial ridge - shin
  - 2. Muscles of the leg
    - a. Gastrocnemius and the soleus - calf
    - b. Tibialis anterior
- D. The ankle
  - 1. Bony prominences
    - a. Lateral and medial malleolus
    - b. Calcaneus
  - 2. Palpable tendons
    - a. Calcaneal tendon - achilles
    - b. Tibialis anterior tendon
- E. The foot
- F. Vessels and nerves of the lower extremity
  - 1. Sciatic nerve - hip
  - 2. Femoral artery - palpable in the femoral triangle
  - 3. Popliteal artery - palpable in the popliteal fossa
  - 4. Dorsalis pedis artery - palpable on top of the foot
  - 5. Saphenous veins - may be visable

VII. Observation of Autopsy (By the end of the quarter each student should have observed an autopsy so that he can relate structures learned in class with actual structures observed.)

REFERENCES:

Anthony, Catherine Parker and Norma Jane Kilthoff. Textbook of Anatomy and Physiology. St. Louis: The C. V. Mosby Co., 1971.

Gray, Henry. Anatomy of the Human Body. 29th ed. Charles M. Goss, editor. Philadelphia: Lea & Febiger, 1973.

Leeson, C. Roland and Thomas S. Leeson. Human Structure: A Companion to Anatomical Studies. Philadelphia: W. B. Saunders Co., 1972.

Wischnitzer, Saul. Outline of Human Anatomy. Springfield, Illinois: Charles C. Thomas, Publisher, 1972.

TEACHING AIDS:

Skeleton
3 X 5 and 2 X 2 slide projections
3 X 5 and 2 X 2 slides
X-ray films
Volunteer subjects within the class

NMT 103 NUCLEAR MEDICINE TECHNOLOGY III

PLACEMENT: Third Quarter

COURSE DESCRIPTION:

A study of the in vivo nuclear medicine procedures. Patient preparation for these procedures will be emphasized.

COURSE HOURS PER WEEK: Class 1; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 1

PREREQUISITE: NMT 102 Nuclear Medicine Technology II

SUGGESTED TEXTBOOK:

Maynard, C. Douglas. Clinical Nuclear Medicine. Text ed. Philadelphia: Lea & Febiger, 1969.

Method of instruction includes reports of assigned reading and guided discussions.

COURSE OBJECTIVE: The student will be able to:

1. Describe the various in vivo procedures.
2. Explain the correct patient preparation for a certain procedure.

COURSE OUTLINE:

I. In Vivo Procedures
    A. Thyroid gland
        1. Thyroid uptake
        2. Thyroid scan
    B. Gastrointestinal tract
        1. Liver scan
        2. Pancreas
    C. Cardiovascular system - cardiac blood pool scanning
    D. Nervous system - brain scan
    E. Pulmonary system - pulmonary perfusion
    F. Genitourinary system
        1. Renal scan
        2. Renogram

II. Summary Reports and Evaluations

FOURTH QUARTER

CHM 203 BIOCHEMISTRY

PLACEMENT: Fourth Quarter

COURSE DESCRIPTION:

The chemistry of the main classes of compounds of biological importance and the major metabolic process of living organisms are discussed.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: CHM 110 General Chemistry II

SUGGESTED TEXTBOOK:

Neal, Leslie A., Chemistry and Biochemistry: A Comprehensive Introduction. New York: McGraw-Hill Book Co., 1971.

COURSE OBJECTIVE: To provide the student with a basic understanding of biochemistry.

COURSE OUTLINE:

I. Carbohydrates

  A. Classification
    1. Monosaccharides
    2. D and L family
    3. Oligosaccharides
    4. Polysaccharides
  B. Monosaccharides
    1. Structure
      a. Rules for writing Haworth formulas
      b. OH configuration
      c. Mutarotation
    2. Reactions
      a. Glycoside formation
      b. Alkali
      c. Oxidation
      d. Dehydration
  C. Individual monosaccharides
    1. Trioses
    2. Tetroses
    3. Pentoses
    4. Hexoses

- D. Oligosaccharides - disaccharides
- E. Chemical properties of disaccharides
  - 1. Oxidation
  - 2. Mutarotation
- F. Polysaccharides
  - 1. Starch
  - 2. Glycogen
  - 3. Cellulose
  - 4. Inulin

II. Lipids

- A. Classification
  - 1. Simple
  - 2. Compound
  - 3. Miscellaneous
- B. Simple lipids
  - 1. Triglycerides
  - 2. Fats and oils
  - 3. Nomenclature
  - 4. Reactions
    - a. Oxidation
    - b. Hydrolysis and saponification
    - c. Hydrogenation
- C. Phospholipids
  - 1. Phosphatides
  - 2. Lecithins
  - 3. Cephalins
  - 4. Sphingolipids
- D. Glycolipids
- E. Miscellaneous lipids
  - 1. Sterols
  - 2. Carotenoids

III. Amino Acids and Proteins

- A. Amino acid classification
  - 1. Optical isomers
  - 2. Reactions
    - a. Ionization and titration
    - b. Oxidation
  - 3. Peptides
- B. Proteins
  - 1. Classification of proteins
    - a. Simple proteins
      - (1) Albumins
      - (2) Globulins
      - (3) Globins
      - (4) Histones
      - (5) Prolamines
      - (6) Albuminoids

        - b. Conjugated proteins
            - (1) Chromoprotein
            - (2) Phosphoprotein
            - (3) Glycoprotein
            - (4) Lipoprotein
            - (5) Nucleoprotein
    - 2. Primary structure of proteins - amino acid sequence
    - 3. Secondary structure of proteins
        - a. Helix structure
        - b. Pleated - sheet structure
    - 4. Tertiary structure of proteins
    - 5. Quanternary structure of proteins
    - 6. Denaturation of proteins
    - 7. Complete and incomplete proteins

IV. Nucleotides and Nucleic Acids

- A. Nucleoside and nucleotide composition
    - 1. Bases
    - 2. Carbohydrates
    - 3. Nucleosides
    - 4. Nucleotides
    - 5. High energy nucleotides
- B. Nucleic acids
    - 1. Base composition
    - 2. Structure
- C. Transfer or soluble, RNA
- D. Messenger RNA
- E. Deoxyribonucleic acid

V. Enzymes - Mechanics

- A. Classification of nomenclature
- B. Energetics
    - 1. Free energy
    - 2. Energy of activation
    - 3. Active site
    - 4. Factors affecting activity
        - a. Temperature
        - b. pH
        - c. Substrate concent
- C. Inhibition
    - 1. Product
    - 2. Feedback
    - 3. Competitive
    - 4. Non competitive
- D. Inhibitor
- E. Activation

VI. Classification of Enzymes - Coenzymes

A. Niacin, nicotinamide
B. Vitamin B_2, riboflavin
C. Vitamin B_1, thiamin
D. Lipoic acid
E. Pantothemic acid
F. Biotin
G. Vitamin B_{12}

VII. Enzymes - Digestive

A. Digestive fluids
B. Carbohydrates
C. Polysaccharides
D. Disaccharides
E. Absorption
F. Lipids
G. Triglycerides
H. Protein
  1. Renin
  2. Pepsin
  3. Trypsin
  4. Chymotrypsin
I. Peptides
  1. Exopeptidose
  2. Carboxypeptidose
  3. Aminopeptidose

NMT 125 FILM PROCESSING

PLACEMENT: Fourth Quarter

COURSE DESCRIPTION:

A study of theory and practice in processing exposed radiographic plates. Demonstrations of proficiency for distinctly readable final product are required.

COURSE HOURS PER WEEK: Class 1; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEXTBOOKS:

Cahoon, John B., _Formulating X-Ray Techniques_ 8th ed. Durham, North Carolina: Duke University Press, 1974.

Fuchs, Arthur W., _Principles of Radiographic Exposure and Processing_. 2nd ed. Springfield, Illinois: Charles C. Thomas, Publisher, 1971.

National Naval Medical Center. _Fundamentals of Radiologic Technology_. Stock #0845-0012. Washington, D. C.: Superintendent of Documents, U. S. Government Printing Office.

COURSE OBJECTIVE: The student will be able to:

1. Develop the knowledge and skills necessary for thorough and efficient darkroom procedure.

2. Study the history and development of X-ray film and darkroom accessories.

3. Gain a thorough knowledge of the chemical constituents of processing solutions and their functions.

4. Appreciate various types of darkroom and processing apparatus.

COURSE OUTLINE:

I. Need of Good Darkroom Procedures and Construction

    A. Radiography begins and ends in darkroom
    B. Darkroom construction and equipment

II. Photographic Process

   A. Fundamentals
   B. X-ray film
   C. Handling of X-ray film

III. The Developer in Hand Tank Processing

   A. Function of developer
   B. Chemicals
   C. Effect of temperature on development rate and life of solution
   D. Exhaustion of developer
   E. Replenishment

IV. Rinsing in Hand Tank Processing - Purpose and Methods of Rinsing

V. Fixer and Hypo in Hand Tank Processing

   A. Function
   B. Chemicals
   C. Fixing time
   D. Exhaustion of fixer

VI. Washing in Hand Tank Processing - Purpose and Method

VII. Drying in Hand Tank Processing - Method

VIII. Preparation of Solutions for Hand Tank Processing

   A. Suitable water supply
   B. Suitable materials for mixing vessels
   C. Order of mixing processing solutions
   D. Storage of dry chemicals and solutions
   E. Necessity for temperature control

IX. Types and Care of Processing Apparatus

   A. Suitable materials for processing tanks
   B. Conventional large tanks
   C. Small (dental) tanks
   D. Tru-wall units
   E. Tray processing

X. Automatic Processing

   A. Types of automatic processors
   B. Theory of roller processing
   C. Changes in chemistry from hand processing
   D. Need for periodic cleaning and inspection of rollers, gears, filter, etc.
   E. "Trouble shooting" with an automatic processor

XI. Theory of the Photographic Process

- A. Latent image
- B. Density and gamma
- C. Emulsion characteristics
- D. Resolution
- E. Evaluation tests for contrast, speed, latitude, etc.

XII. Reduction of Over-exposed Radiographs

- A. Farmer's reducer
- B. Other reducers

XIII. Film Artifacts and Their Causes

- A. Fog
  - 1. Light
  - 2. Chemical
  - 3. Age
- B. Increased density artifacts
- C. Decreased density artifacts
- D. Common artifacts
- E. Artifacts due to mechanical processing

NMT 104 NUCLEAR MEDICINE TECHNOLOGY IV

PLACEMENT: Fourth Quarter

COURSE DESCRIPTION:

A continuation of the nuclear medicine technology series which emphasizes special *in vitro* procedures.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: NMT 103 Nuclear Medicine Technology III

SUGGESTED TEACHING METHODS: Method of instruction includes reports of assigned reading and guided discussion.

COURSE OBJECTIVE: The student will be able to display the ability to understand the basic principles of the *in vitro* procedures.

COURSE OUTLINE:

I. Introduction to *In Vitro* Procedures

    A. Hematologic
        1. Schillings
        2. Blood volume
        3. RBC mass
        4. RBC survival
        5. Fe clearance
        6. Fe utilization
    B. Radioimmunoassay
        1. Triiodothyronine
        2. Digitoxins
        3. Digoxins
        4. Serum B-12
        5. HAA
        6. T-3
        7. T-4
        8. UBBC
        9. Cortisols

II. Summary Reports and Evaluations

NMT 129 PRACTICUM I

PLACEMENT: Fourth Quarter

COURSE DESCRIPTION:

Directed clinical learning experiences in special areas of the nuclear medicine laboratory. Radionuclide generators, radiation safety, and management and administration of nuclear medicine department will be presented in lecture series.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 12

QUARTER HOURS CREDIT: 4

PREREQUISITE: None

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: The student will be able to:

1. Position patients for routine organ imaging.
2. Process and develop exposed film.
3. Number and file the film and reports of in vitro studies according to the procedure used in the clinical facility or affiliated agency.
4. Evaluate the finished scan or scintophoto.
5. Display the ability to function within a nuclear medicine department.

COURSE OUTLINE:

I. Supervised Learning Experiences in Clinical Area
   (All learning experience should progress from observation to assisting the staff technologist to the student's doing the work with the supervision of the registered nuclear medicine technologist.)
   A. Orientation to hospital
      1. Rules and regulations of the hospital and the nuclear medicine department
      2. Tour of hospital
   B. Work in reception and area and file room
   C. Work in scan uptake and camera rooms

II. Staff Lectures

- A. Radionuclide generators
  - 1. Radionuclide generators
  - 2. ^{99m}Tc compounds
  - 3. Units
  - 4. Calculations of doses
  - 5. Records
- B. Introduction to radiation safety
  - 1. Radiation as a resource for man
  - 2. Kinds of radiation exposure
  - 3. Occupational radiation
  - 4. Kinds of exposure
  - 5. Radiation control
    - a. Degree of control
    - b. Controlled area
- C. Introduction to clinical nuclear medicine
  - 1. Basic instrumentation
    - a. Scintillation well counter
    - b. Stationary probes
    - c. Scanners
    - d. Scintillation camera
  - 2. Clinical use of radiopharmaceuticals
    - a. Methods of localization
    - b. Selection of a radiopharmaceutical
  - 3. The thyroid
  - 4. Hematological studies
  - 5. Treatment of malignant disease with radiocolloids
  - 6. Gastrointestinal tract
  - 7. Cardiovascular system
  - 8. Nervous system
  - 9. Pulmonary system
  - 10. Genitourinary system
  - 11. Skeletal system
- D. Management and administration of a nuclear medicine department
  - 1. Records
  - 2. Ordering supplies
  - 3. Securing equipment and personnel
  - 4. Budget for nuclear medicine department
  - 5. Technologist - physician relationship
  - 6. Technologist - patient relationship

REFERENCES:

"Basic Radiation Protection Criteria." NCRP Report No. 39, 1971.

Maynard, C. Douglas. Clinical Nuclear Medicine. Philadelphia: Lea & Febiger, 1969.

FIFTH QUARTER

NMT 116 NUCLEAR PHYSICS

PLACEMENT: Fifth Quarter

COURSE DESCRIPTION:

An introduction of the student to the basic concepts of atomic and nuclear radiation physics. Nuclear decay schemes and concepts of radioactive decay are discussed, followed by a thorough discussion on the interactions of radiation with matter.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: PHY 115 Physics

SUGGESTED TEXTBOOKS:

Arena, Victor. Ionizing Radiation and Life. St. Louis: The C. V. Mosby Co., 1971.

Blahd, William H., Nuclear Medicine. 2nd ed. New York: McGraw-Hill Book Co., 1971.

Lange, Robert C., Nuclear Medicine for Technicians. Chicago: Year Book Medical Publishers, Inc., 1973.

Powsner, Edward P. and David E. Raeside. Diagnostic Nuclear Medicine. New York and London: Grune and Stratton, Inc., 1971.

Quimby, Edith H., Sergi Feitelberg, and William Gross. Radioactive Nuclides in Medicine and Biology. 3rd ed. Philadelphia: Lea & Febiger, 1970.

Wagner, Henry N., Jr., ed. Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

COURSE OBJECTIVE: The student will be able to:

1. Become acquainted with basic atomic and nuclear physics, especially as related to nuclear medicine.
2. Become acquainted with concepts of radioactive decay.
3. Understand the events involved with the interaction of radiation with matter.

COURSE OUTLINE:

I. History of Atomic Concept

   A. Atomic building blocks
   B. Present picture of atomic structure
   C. Periodic table
   D. Isotopes
   E. Nuclear nomenclature
      1. Atomic number
      2. Neutron number
      3. Mass number
   F. Classification of stable nuclei

II. Radioactivity

   A. Nature of radiations
      1. Alpha
      2. Beta
      3. Gamma
   B. Atomic disintegration
   C. Artificial or induced radioactivity
   D. Characteristics of radioactive disintegration
   E. Mathematical expression of disintegration law
   F. Half life and average life
   G. Determination of decay constants
   H. Units of activity of radioactive nuclides
      1. Curie
      2. Millicurie
      3. Microcurie
      4. Nanocurie
   I. Specific activity

III. Induced Radioactivity - First Artificial Transmutation

   A. Discovery of the neutron
   B. Discovery of the positron
   C. Artificially produced radionuclides
   D. The cyclotron

IV. Energy of Nuclear Reactions

   A. Equivalence of mass and energy
   B. Notation for nuclear reactions
   C. Mechanisms of nuclear reaction
   D. Yield of nuclear reaction
   E. Reactions in
      1. Neutron
      2. Proton
      3. Deuteron
      4. Alpha particle

F. Nuclear reactions produced by protons
G. Energy considerations

V. Nuclear Fission and Fusion - Discovery

A. Fission products
B. Nuclear chain reaction
C. Atomic pile or nuclear reactor
D. Transuranic elements
E. Radionuclide production in the pile
F. Nuclear weapons
G. Nuclear fusion

VI. Sources of the Radiations

A. Radioactive decay
  1. Alpha decay
  2. Beta decay
    a. Neutrino
    b. Average and maximum beta energy
  3. Electron capture
  4. Gamma decay
  5. Internal conversion
  6. Isomeric transition
  7. Other modes of decay
B. Isotope chart
  1. Radioactive series
  2. Radioactive equilibrium
  3. Growth of radionuclide in neutron flux

VII. Interaction of Radiation and Matter - Characteristics of the Radiations

A. Energies of the radiations
B. Possible types of interactions of radiation and matter
C. Interactions of alpha particles with matter
D. Interactions of beta particles with matter
E. Interactions of neutrons with matter
F. Interactions of photons with matter
G. Ionization, recombination and production of characteristic radiation
H. Wilson cloud chamber
I. Absorption of beta radiation
J. Range of beta particles
K. Scattering of beta particles
L. Self-scattering and self-absorption of beta particles
M. Absorption and scattering of photon beams

REFERENCES:

Evans, Robley D., The Atomic Nucleus. 14th printing. New York: McGraw-Hill Book Co., 1972.

Johns, Harold E. and John R. Cunningham. The Physics of Radiology. 3rd ed. Springfield, Illinois: Charles C. Thomas, Publisher, 1971.

Kaplan, Irving. Nuclear Physics. 2nd ed. London: Addison-Wesley Publishing Co., Inc., 1964.

Semat, Henry and John R. Albright. Introduction to Atomic and Nuclear Physics. 5th ed. New York: Holt, Rinehart and Winston, Inc., 1972.

NMT 269 PRACTICUM II

PLACEMENT: Fifth Quarter

COURSE DESCRIPTION:

Practical experience in a clinical setting with emphasis on scanning. Radiation protection practices and routine quality control of the instruments will be observed and used.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 30

QUARTER HOURS CREDIT: 10

PREREQUISITE: NMT 129 Practicum I

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVES: The student will be able to:

1. Use special immobolizing techniques for uncooperative patients.

2. Do routine quality control checks on
   a. Scintillation well counters
   b. Scintillation cameras
   c. Scanners

3. Use nomograms for setting up scanners.

4. Position patients for special views.

COURSE OUTLINE:

I. Supervised Learning Experiences in Clinical Facilities

   A. Work in scanning areas
   B. Practice in routine quality control of instruments
   C. Practice of applied radiation safety procedures

II. Discussion by Students on Selected Topics Related to Clinical Nuclear Medicine

NMT 111 PRINCIPLES OF NUCLEAR MEDICINE I

PLACEMENT: Fifth Quarter

COURSE DESCRIPTION:

An introductory course in clinical nuclear medicine. The basic principles of the major *in vivo* studies and major clinical nuclear medicine procedures will be introduced.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEXTBOOK:

Maynard, C. Douglas. *Clinical Nuclear Medicine*. Text ed. Philadelphia: Lea & Febiger, 1969.

COURSE OBJECTIVE: To give the student a beginning understanding of the more commonly employed clinical test in nuclear medicine.

COURSE OUTLINE:

I. Radiopharmaceuticals

II. Instrumentation

III. Liver Imaging

    A. Architectural
    B. Biliary patency

IV. Lung Scanning

    A. Perfusion
    B. Aerosol

V. Cardiac Studies

    A. Static imaging
    B. Dynamic imaging

VI. Thyroid

    A. Function studies
    B. Imaging

VII. Central Nervous System

  A. Brain scanning
  B. Dynamic studies
  C. Cisternography

VIII. Skeletal Imaging

IX. Renal Studies

  A. Scanning
  B. Renogram
  C. Dynamic studies

X. Blood Volume

  A. RBC mass
  B. Plasma volume

XI. RBC Survival

XII. B-12 Absorption

XIII. Pancreas Scanning

REFERENCES:

Blahd, W., et al. The Practice of Nuclear Medicine. Springfield, Illinois: Charles C. Thomas, Publisher, 1968.

Silver, S., Radioactive Isotopes in Medicine and Biology - Medicine. Philadelphia: Lea & Febiger, 1962.

Wagner, Henry H., Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

NMT 255 INTRODUCTION TO RADIOIMMUNOASSAY

PLACEMENT: Fifth Quarter

COURSE DESCRIPTION:

A review of the basic units of measurement, with emphasis on the metric system. The organization of living matter from the chemical view is discussed. Emphasis will be placed on protein structure and competitive protein binding analysis.

COURSE HOURS PER WEEK: Class 1; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEXTBOOK:

Behrman, H. R. and B. M. Jaffe, editors. Methods of Hormone RIA. New York: Academic Press, Inc., 1974.

COURSE OBJECTIVE: The student will be able to:

1. Enlarge his medical vocabulary.

2. Comprehend the nuclear medicine laboratory request and patient's medical history.

3. Make an intelligent inquiry regarding a nuclear medicine lab request to the laboratory director if the patient's pathology should seem to require a change in the request.

COURSE OUTLINE:

I. Quantitation

    A. Units of measurement
        1. Length
        2. Area
        3. Volume
    B. Metric system - weight of units of biophysical matter, electron through adult man
    C. Review
        1. Meaning of Avogadro's number
        2. Calculation of molecular weight - water through thyroxine

II. Organization of Living Matter from the Chemical View

    A. Relation of different science disciplines to one another
    B. Emphasize how science disciplines differ from one another, not in principle, but only in size of the unit studied

   C. Why biochemistry

III. Chemical Bonds and Role of Water

   A. Emphasis on differences in bond strength between
      1. Van der Waals forces
      2. Ionic bonds
      3. Covalent
   B. Nonpolar covalent vs. polar covalent
   C. Structure of water
   D. Role of water in chemical reactions and living systems

IV. Concept of pH and Buffers

   A. Definitions
      1. pH
      2. Acids
      3. Bases
   B. pH as a concentration unit
   C. Ionization of weak acids plus bases
   D. Mechanism of buffer action
   E. Calculation of pH from H^+ concentration

V. Protein Structure

   A. Amino acid - chemical nature and classes
   B. Peptide bond
   C. Size relationship
      1. Amino acid
      2. Peptides + proteins
   D. Protein molecules
      1. Primary structure
      2. Secondary structure
      3. Tertiary structure

VI. Protein Binding and Protein Denaturation

   A. Shape of protein molecules
   B. "Binding site"
   C. Chemical forces involved in binding
   D. Denaturation - disruption of binding site
   E. Protein denaturing agents and mechanism of actions

VII. Biologic Role of Proteins and Blood; Definition of Vitamins, Hormones and Enzymes

   A. Types and function of protein classes in biology
   B. Composition of blood
   C. Classes of plasma proteins
   D. Enzymes as a special class of binding proteins

- E. Definition of hormone
  - 1. Chemical classes of hormones
  - 2. Survey of endocrine glands

VIII. Competitive Protein Binding Analysis I - General Principles

- A. Saturation analysis
- B. Classes of competitive protein binding analysis
- C. Principle of CPB
- D. Calibration of CPB assays - standard curves
- E. Details of four requirements for CPB
  - 1. Binder
  - 2. Radioligand
  - 3. Separation techniques
  - 4. Standards
- F. Variations in CPB technique
  - 1. Liquid phase
  - 2. Solid phase
    - a. Coated antibody
    - b. Coupled antibodies

IX. Competitive Protein Binding Analysis II - Specific Analysis

- A. Saturation analysis
  - 1. R t_3 U test
  - 2. UBBC
  - 3. Australia antigen testing
- B. Direct serum - liquid CPB analysis
  - 1. Gastrin
  - 2. Triiodothyronine
  - 3. Digoxin
  - 4. Digitoxin
  - 5. Thyroid stimulating hormone

X. Competitive Protein Binding Analysis III - Specific Analysis

- A. Direct serum - solid phase CPB analysis
  - 1. Growth hormone
  - 2. Insulin
  - 3. Ig E
- B. Extracted serum - liquid CPB analysis
  - 1. t_4
  - 2. B_{12}
  - 3. Cortisol
  - 4. ACtH
- C. Liquid CPB analysis on compound generated in sample - plasma renin activity

XI. Quality Control of Laboratory Results

- A. Definition of terms
  1. Standard
  2. Control serum
  3. Accuracy
  4. Prevision
- B. Review of statistics
  1. Mean
  2. Standard deviation
  3. Cofficient of variation
  4. Normal distribution

REFERENCES:

Arnow, L. Earle and K. D. Dreves. Introduction to Physiology and Pathological Chemistry. 8th ed. St. Louis: The C. V. Mosby Co., 1972.

"Handbook of Laboratory Safety." First edition. Cleveland, Ohio: Chemical Rubber Company.

Lenninger, Albert L., Biochemistry. New York: Worth Publishers, Inc., 1972.

Pritham, Gordon H., Anderson's Essentials of Biochemistry. St. Louis: The C. V. Mosby Co., 1968.

White, Abraham, Philip Handler, and Emil L. Smith. Principles of Biochemistry. 4th ed. New York: McGraw-Hill Book Co., 1968.

NMT 268 OPEN LAB PRACTICUM I

PLACEMENT: Fifth Quarter

COURSE DESCRIPTION:

Clinical experience as conducted under evening and weekend emergency conditions.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 6

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: To acquaint the student with the procedures required for use during emergency situations.

COURSE OUTLINE:

I. Supervised Learning Experience in Clinical Facilities

II. Transfer of Theory into Clinical Practice in Emergency Situations

III. Clinical Evaluation

SIXTH QUARTER

NMT 274 PRACTICUM III

PLACEMENT: Sixth Quarter

COURSE DESCRIPTION:

Practical experience in a clinical setting, with emphasis on the more advanced applications in nuclear medicine procedures. Preparation and use of radiopharmaceuticals; preparation of the patient for such studies as bone and ^{67}GA.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 30

QUARTER HOURS CREDIT: 10

PREREQUISITE: NMT 269 Practicum II

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: The student will be able to:

1. Prepare radiopharmaceuticals.
2. Give instructions to the patient about pre-examination preparation.
3. Do delayed and follow-up scans.

COURSE OUTLINE: (Supervised Learning Experiences in Clinical Facilities)

I. Radiopharmaceutical Preparation
   A. Completing necessary requests for amount and type of radiopharmaceutical
   B. Instructing nursing personnel and patients on the preparation of patients for various nuclear medicine procedures
   C. Assisting the physician during the injection of the radiopharmaceutical

II. Work in the Scanning and Imaging
   A. Bone scanning
   B. ^{67}GA scanning

NMT 230 NUCLEAR MEDICINE INSTRUMENTATION I

PLACEMENT: Sixth Quarter

COURSE DESCRIPTION:

A study of practical electronic design of radiation detection instruments and circuit construction. Use of such instruments as the Geiger-Muller counter, ionization chambers, proportional counters, and radiation monitoring devices are discussed. Statistics related to nuclear counting are introduced.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: NMT 116 Nuclear Physics

SUGGESTED TEXTBOOK:

Simmons, Guy H., A Training Manual for Nuclear Medicine Technologists. Washington, D. C.: U. S. Department of Health, Education and Welfare, Public Health Service, BRH/DMRE 70-3.

COURSE OBJECTIVE: The student will be able to:

1. Understand the basis of radiation detection.

2. Demonstrate poise and confidence in using the above mentioned instruments.

COURSE OUTLINE:

I. Detection of Radiation

    A. Geiger-Muller counter
        1. General remarks
        2. Types of equipment
    B. Ionization chambers
    C. Proportional counters
    D. Calibration and care of survey instruments
    E. Instrument design

II. Statistical Fluctuations in Nuclear Processes

    A. Frequency distribution
        1. The binomical distribution
        2. The normal distribution
        3. The poission distribution

B. Statistical characterization of data
    1. Mean value
    2. Standard deviation
    3. Variance
    4. Standard error
    5. Probable error
    6. Dimensions of statistical parameters
C. Pearson's Chi-Square Test

REFERENCES:

Chase, Grafton D. and Joseph L. Rabinowitz. Principles of Radioisotope Methodology. 3rd ed. Minneapolis: Burgess Publishing Co., 1968.

Evans, Robley D., The Atomic Nucleus. 14th Printing. New York: McGraw-Hill Book Co., 1972.

Huntsberger, David V., Elements of Statistical Inference. 2nd ed. Boston: Allyn and Bacon, Inc., 1969.

Price, W. J., Nuclear Radiation Detection. New York: McGraw-Hill Bood Co., 1955.

Quimby, Edith H., Sergi Feitelberg, and William Gross. Radioactive Nucledies in Medicine and Biology. 3rd ed. Philadelphia: Lea & Febiger, 1970.

NMT 221 PRINCIPLES OF NUCLEAR MEDICINE II

PLACEMENT: Sixth Quarter

COURSE DESCRIPTION:

Principles and applications of radionuclide studies of the gastrointestinal and cardiopulmonary systems.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: NMT 111 Principles of Nuclear Medicine I

SUGGESTED TEXTBOOK:

Maynard, C. Douglas. Clinical Nuclear Medicine. Philadelphia: Lea & Febiger, 1969.

COURSE OBJECTIVE: To give the student a thorough knowledge of the fundamentals involved in the performance of these clinical procedures.

COURSE OUTLINE:

I. General Topics

  A. Review
    1. Anatomy
    2. Physiology
    3. Pathology
  B. Radiopharmaceuticals
    1. Biological behavior
    2. Physical characteristics
    3. Radiation exposure
    4. Customary dosages
  C. Instrumentation
  D. Techniques
    1. Preparation
    2. Timing
    3. Positioning
    4. Views
    5. Special considerations
  E. Clinical applications
    1. Indications for study
    2. Sensitivity
    3. Specificity
    4. Comparison to other techniques
    5. Usefulness of information to the patient

II. Topics To Be Covered

- A. Liver
  - 1. RES visualization
  - 2. Biliary patency
- B. Spleen
  - 1. RES visualization
  - 2. RBC sequestration
  - 3. Platelet sequestration
- C. Lung-liver imaging
- D. Pancreas
- E. Lung
  - 1. Perfusion studies
  - 2. Inhalation studies (radioaerosol)
  - 3. Ventillation techniques
- F. Cardiac
  - 1. Static blood pool imaging
  - 2. Dynamic imaging
  - 3. Myocardial imaging
- G. Placental localization
- H. Gallium tumor localization
- I. Treatment of malignant effusions

REFERENCES:

Blahd, William, et al. The Practice of Nuclear Medicine. Springfield, Illinois: Charles C. Thomas, Publisher, 1968.

Silver, S., Radioactive Isotopes in Medicine and Biology - Medicine Philadelphia: Lea & Febiger, 1962.

Wagner, Henry H., Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

NMT 223 RADIOPHARMACEUTICALS I

PLACEMENT: Sixth Quarter

COURSE DESCRIPTION:

Introduction to radiopharmacy functions, production of radionuclides, quality control of radiopharmaceuticals, and radiopharmacy mathematics.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: The student will be:

1. Introduced to F.D.A. and A.E.C. requirements for the development and human use of radiopharmaceuticals.
2. Introduced to safe handling of radiopharmaceuticals in regard to radiation safety.

COURSE OUTLINE:

I. Regulatory Agencies

    A. FDA
    B. AEC

II. Radiopharmacy Mathematics

    A. Basic units
    B. Dose calculations

III. Production of Radionuclides

    A. Naturally occurring radioactive nuclides
    B. Nuclear reactors - produced nuclides
        1. Neutron bombardment
        2. Fission by-products
    C. Cyclotron produced radionuclides

IV. Radiopharmacy Functions

    A. Procurement of radiopharmaceuticals

B. Preparation of compounds
    1. Colloids
    2. Microaggregates
    3. Macroaggregates
    4. Microspheres
    5. DtPa preparation
    6. Polysphosphate
C. Quality control procedures
    1. Pharmaceutical considerations
        a. Inspection of labeling and contents
        b. Appearance
        c. pH determination
    2. Radiation considerations
        a. Radionuclides identify and purity
        b. Radionuclides activity assay
        c. Radiochemcial purity
D. Records

REFERENCES:

Buiner, William H., Radiopharmaceutical Quality Control. Continuing Education Lectures, Southeastern Chapter Society of Nuclear Medicine, 1971.

"Radioactive Pharmaceuticals." AEC Division of Technical Information. CONF - 651111, 1966.

Wagner, Henry N., ed. Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

NMT 117 HEALTH PHYSICS

PLACEMENT: Sixth Quarter

COURSE DESCRIPTION:

Introduction to radiation safety techniques for reducing exposure to physicians, technologists, and patients. Atomic Energy Commission and State regulations, and monitoring methods for nuclear medicine departments will be emphasized.

COURSE HOURS PER WEEK: Class 1; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 1

PREREQUISITE: PHY 115 Physics

SUGGESTED TEXTBOOK:

Shapiro, Jacob. Radiation Protection: A Guide for Scientists and Physicians. Cambridge, Massachusetts: Harvard University Press, 1972.

COURSE OBJECTIVE: The student will be able to:

1. Intelligently select the proper survey instrument for department monitoring.

2. Set up a radiation safety program for a nuclear medicine department.

3. Interpret State and federal regulations regarding radiation safety.

COURSE OUTLINE:

I. Introduction

    A. Radiation units
        1. Roentgen
        2. Rad
        3. Rem
    B. Maximum permissible doses
        1. Occupational
        2. Non-occupational
    C. Absorption processes and radiation shields
        1. Photoelectric effect
        2. Compton scattering
        3. Pair production
        4. Annihilation radiation
        5. HVL
        6. TVL
        7. Specific gamma constant

E. Radiation measurements
    1. G-M counter
        a. Calibration
        b. Detecting gamma photons
    2. Detectors for special counting problems
F. Practical aspects of the use of radiopharmaceuticals
    1. Obtaining authorization
    2. Responsibilities of users
    3. Standards for radiation exposure
    4. Personnel monitoring
    5. Personnel contamination and decontamination
    6. Notification of authorities

REFERENCES:

"Basic Radiation Protection Criteria." NCRP Report No. 39, 1971.

"Protection Against Radiation from Brachytherapy Sources." NCRP Report No. 40.

"Precautions in the Management of Patients Who Have Received Therapeutic Amounts of Radionuclides." NCRP Report No. 37.

Quimby, Edith H., Sergi Feitelberg, and William Gross. Radioactive Nuclides in Medicine and Biology. 3rd ed. Philadelphia: Lea & Febiger, 1970.

"Recommendations for Waste Disposal of ^{32}P and ^{131}I for Medical Users." Handbook, U. S. Department of Commerce, National Bureau of Standards, 1951.

NMT 273 OPEN LAB PRACTICUM II

PLACEMENT: Sixth Quarter

COURSE DESCRIPTION:

Clinical experience conducted under evening and weekend emergency conditions, with more emphasis on student participation in clinical procedures and patient contact.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 6

QUARTER HOURS CREDIT: 2

PREREQUISITES: NMT 268 Open Lab Practicum I; NMT 269 Practicum II

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: To acquaint the student with the procedures required for use during emergency situations.

COURSE OUTLINE:

I. Supervised Learning Experiences in Clinical Facilities

II. Transfer of Theory into Clinical Practice

III. Clinical Evaluation

SEVENTH QUARTER

NMT 279 PRACTICUM IV

PLACEMENT: Seventh Quarter

COURSE DESCRIPTION:

Practical experience in a clinical setting, with emphasis on in-vitro procedures and therapeutic use of radionuclides. Thes course will also relate all theory presented during the first three quarters of practicums.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 30

QUARTER HOURS CREDIT: 10

PREREQUISITE: NMT 274 Practicum III

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: The student will be able to:

1. Participate in the actual performance of the in-vitro procedures.

2. Assist the physician in the dosing of patients with a therapeutic amount of radionuclide.

3. Display some knowledge of all the general principles of nuclear medicine.

COURSE OUTLINE:
(Supervised Learning Experiences in Clinical Facilities)

I. Rotation Through In-vitro Lab

2. Work with Physicians During the Dosing of a Patient with a Therapeutic Amount of a Radionuclide

NMT 240 NUCLEAR MEDICINE INSTRUMENTATION II

PLACEMENT: Seventh Quarter

COURSE DESCRIPTION:

A study in detail of the use of well counter, scanners, cameras, single channel and multichannel analyzers as related to clinical nuclear medicine. Emphasis is placed upon NaI(Tl) detectors, GeLi detectors, amplifiers, spectrometers, ratemeter and scalers.

COURSE HOURS PER WEEK: Class 3; Lab 2; Practicum 0

QUARTER HOURS CREDIT: 4

PREREQUISITE: NMT 230 Nuclear Medicine Instrumentation I

SUGGESTED TEXTBOOKS:

Chase, G. D. and J. L. Rabinowitz. Principles of Radioisotope Methodology. 3rd ed. Minneapolis: Burgess Publishing Co., 1967.

Lederer, C. M., J. M. Hollander, and I. Perlman. Table of Isotopes. New York: John Wiley and Sons, Inc., 1967.

Price, W. J., Nuclear Radiation Detection. New York: McGraw-Hill Book Co., 1955.

Wagner, H. N., ed. Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

Wang, Y., ed. ERC Handbook of Radioactive Nuclides. Cleveland: The Chemical Rubber Co., 1969.

COURSE OBJECTIVE: The student will be able to operate effectively all available instrumentation in the nuclear medicine department with the precision and accuracy in yielding a valid diagnostic result.

COURSE OUTLINE:

I. Characteristics of Scintillation Phosphors - Elements of a Scintillation Counting System

    A. Characteristics of photomultiplier tubes
    B. Scintillation phosphors - theory of lumenescence
    C. Counting efficiency of NaI(Tl) crystals
        1. Well crystal
        2. Flat crystal

- D. Variation of efficiency with geometry
- E. Pulse height spectrometry

II. Gamma Counting Systems

- A. Pulse height analyzers
    - 1. Voltage discriminator
        - a. Operation
        - b. Calibration
        - c. Types
    - 2. Computer-type
        - a. Theory
        - b. Calibration
- B. Data presentation - analog readout devices
    - 1. Ratemeter
    - 2. Strip chart recorder
    - 3. Oscilloscope
    - 4. X-Y plotter
- C. Digital readout devices
    - 1. Electric typewriter
    - 2. Parallel printer
    - 3. Paper punch tape
    - 4. Magnetic tape
    - 5. Sealers

III. Liquid Scintillation Counting

- A. Introduction
- B. Instrumentation
- C. The sample
- D. Counting procedure
- E. Special samples

IV. Scanning Instrumentation

- A. Introduction
- B. Rectilinear scanners
    - 1. Detector-collimator assembly
        - a. Collimator
        - b. Type of collimator
        - c. Geometry
        - d. Transmission
    - 2. Detector size and thickness
    - 3. Scan recording mechanisms
        - a. Dot recorders
        - b. Color dot recorders
        - c. Photographic recorders
        - d. Other recording mechanisms
    - 4. Quality control of scanner

V. Stationary Imaging Device - Scintillation Camera

    A. Detector and positioning electronics
    B. Collimators

NMT 241 PRINCIPLES OF NUCLEAR MEDICINE III

PLACEMENT: Seventh Quarter

COURSE DESCRIPTION:

Detailed consideration will be given to principles and applications of radionuclide studies of the endocrine and central nervous systems.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITES: NMT 111 Principles of Nuclear Medicine I; NMT 221 Principles of Nuclear Medicine II

SUGGESTED TEXTBOOK:

Maynard, C. Douglas. Clinical Nuclear Medicine. Philadelphia: Lea & Febiger, 1969.

COURSE OBJECTIVE: To give the student a thorough knowledge of the fundamentals involved in the performance of these clinical procedures.

COURSE OUTLINE:

I. Thyroid

   A. Uptake studies
   B. Thyroid suppression
   C. Thyroid stimulation
   D. Perchlorate discharge test
   E. T-3 resin uptake
   F. Serum thyroxin
   G. Serum triiodothyronine
   H. Thyroid stimulating hormone
   I. Thyroid imaging
   J. Whole body imaging with radioiodine
   K. Therapy of hyperthyroidism
   L. Therapy of thyroid cancer

II. Parathyroid - Localization

III. Adrenal - Imaging

IV. Central Nervous System

   A. Static brain scanning
   B. Dynamic studies
   C. Cisternography

REFERENCES:

Blahd, William, et al. The Practice of Nuclear Medicine. Springfield, Illinois: Charles C. Thomas, Publisher, 1968.

Silver, S., Radioactive Isotopes in Medicine and Biology - Medicine. Philadelphia: Lea & Febiger, 1962.

Wagner, Henry H., Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

NMT 289 RADIOBIOLOGY

PLACEMENT: Seventh Quarter

COURSE DESCRIPTION:

A course in which the fundamentals of radiobiology, a system's sensitivity to radiation (normal and neoplastic), radiation pathology, and the biological effects of radiation are stressed. Emphasis is placed upon the effects of radiation and the effects of radiation absorption on tissue and tissue recovery rate.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: NMT 116 Nuclear Physics

SUGGESTED TEXTBOOKS:

Arena, Victor. Ionizing Radiation and Life. St. Louis: The C. V. Mosby Co., 1971.

Casarett, A. P., Radiation Biology. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961.

Fabrikant, Jacob I., Radiobiology. Chicago: Year Book Publisher, Inc., 1972.

Pizzarello, Donald J. and Richard L. Witcofski. Basic Radiation Biology. Philadelphia: Lea & Febiger, 1970.

COURSE OBJECTIVE: To provide the student with a basic understanding of radiation biology; beginning with the absorption of radiation by cells, tissues, and organs.

COURSE OUTLINE:

I. Review of Pertinent Physics

   A. Introduction: review of atomic physics
   B. Origins and types of ionizing radiations
   C. Background radiation
   D. Interaction of radiation with matter
   E. Measurement of radiation dose

II. Interactions of Radiations with Living Systems

A. Direct and indirect action: action of radiation in aqueous systems
   1. Ionization is random
   2. Energy transfer in complex systems
   3. The interaction of ionizing radiation and water
   4. Free radicals

B. Target theory and the interpretation of survival data
   1. Introduction
   2. Target theory
   3. Application of target theory
   4. Single and multi-hit effects
   5. Single-hit or single-change phenomena

C. Oxygen effect
   1. Conditions under which there is an oxygen effect
   2. Universal effect of oxygen
   3. Dependence on LET
   4. Mechanisms through which the effect occurs
      a. Toxicity of oxygen
      b. Properties of oxygen
      c. Generation of free radicals
      d. Auto-oxidative chain reactions
      e. Direct action
      f. Indirect action
      g. Biologic reduction of oxygen
      h. Oxidation of normal biologic free radicals by oxygen
      i. Chain reactions

D. Review of basic biology: The nucleus: DNA; Introduction
   1. Chromosomes
   2. The genes
   3. Structure of DNA
      a. Components in the macromolecule
      b. Nitrogenous bases
   4. Genetic code

E. Effects in the total organism: The immediate lethal effects
   1. Effects of dose
   2. Radiation syndromes
   3. Organ radiosensitivity

F. Bone-marrow syndrome
   1. Manifestations
   2. Histologic changes
   3. Cytologic changes
   4. The latent period
   5. Blood counts
   6. Infection

G. The gastrointestinal syndrome
   1. Introduction
   2. Degenerative changes in the lining of the small intestine
   3. Histologic changes

    4. Regeneration
    5. Effects on cell renewal
- H. The central nervous system syndrome
    1. Histologic and inflammatory changes
    2. Cytologic changes
    3. Consequences of vascular damage
    4. The immediate causes of death
- I. Late effects of radiation
    1. Sterility
    2. Shortening of life span
    3. Cancer
    4. Latent period
    5. Leukemia
    6. Mechanism of action in radiation induced cancer
    7. Cataracts

REFERENCES:

Andrews, H. L., Radiation Biophysics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961.

Bacq, Z. and P. Alexander. Fundamentals of Radiobiology. New York: Pergamon Press, Inc., 1961.

Claus, W., ed. Radiation Biology and Medicine. Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1958.

NMT 233 RADIOPHARMACEUTICALS II

PLACEMENT: Seventh Quarter

COURSE DESCRIPTION:

A study of radiopharmaceuticals used in nuclear medicine departments on a routine basis. Radiopharmaceuticals of historical and research interest will be emphasized.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: NMT 230 Nuclear Medicine Instrumentation I

SUGGESTED TEXTBOOK:

Simmons, Guy H. A., Training Manual for Nuclear Medicine Technologists. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Public Health Service, BRH/DMRE 70-3.

COURSE OBJECTIVE: To introduce the student to the radiopharmaceuticals that are used routinely in most hopitals.

COURSE OUTLINE:

I. Radiopharmaceuticals Now Used

- A. Generator systems
    - 1. Construction
        - a. Columns
        - b. Eluants
        - c. Yields
        - d. Growth and decay of activity
        - e. Computations of activity
    - 2. Generator used in nuclear medicine
        - a. ^{99}Mo ^{99}Tc
        - b. ^{87}Y ^{87}Sr
        - c. ^{113}Sm ^{113m}IN
        - d. ^{132}Te ^{132}I
- B. Examples of radiopharmaceuticals
    - 1. ^{99m}Tc
    - 2. ^{131}I
    - 3. ^{125}I
    - 4. ^{67}Ga
    - 5. ^{111}In
    - 6. ^{51}Cr
    - 7. ^{75}Se

8. ^{32}P
9. ^{59}Fe
10. ^{113m}In

II. Radiopharmaceuticals of Historical Interest - Introduction

A. ^{198}Hg
B. ^{203}Hg
C ^{198}Ay
D. ^{85}Sr
E. ^{18}F
F. ^{87m}Sr

III. Radiopharmaceuticals Used in Research - Introduction

A. ^{14}C
B. ^{3}H
C. ^{40}K

IV. Radiopharmaceuticals of the Future - Introduction

A. ^{123}I
B. ^{52}Fe
C. ^{43}K

REFERENCES:

Chase, Grafton D. and Joseph L. Rabinowitz. *Principles of Radioisotope Methodology*. 3rd ed. Minneapolis: Burgess Publishing Co., 1968.

Evans, Robley D., *The Atomic Nucleus*. 14th Printing. New York: McGraw-Hill Book Co., 1972.

Huntsberger, David V., *Elements of Statistical Inference*. 2nd ed. Boston: Allyn and Bacon, Inc., 1969.

Price, W. J., *Nuclear Radiation Detection*. New York: McGraw-Hill Book Co., 1955.

Quimby, Edith H., Sergi Feitelberg, and William Gross. *Radioactive Nucledies in Medicine and Biology*. 3rd ed. Philadelphia: Lea & Febiger, 1970.

NMT 278 OPEN LAB PRACTICUM III

PLACEMENT: Seventh Quarter

COURSE DESCRIPTION:

Clinical experience conducted under evening and weekend emergency conditions, with more emphasis on student participation in clinical procedures and patient contact.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 6

QUARTER HOURS CREDIT: 2

PREREQUISITES: NMT 273 Open Lab Practicum II; NMT 274 Practicum III

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: To acquaint the student with the procedures required for use during emergency situations.

COURSE OUTLINE:

I. Supervised Learning Experiences in Clinical Facilities

II. Transfer of Theory into Clinical Practice

III. Clinical Evaluation

EIGHTH QUARTER

NMT 284 PRACTICUM V

PLACEMENT: Eighth Quarter

COURSE DESCRIPTION:

A more detailed study in the design and use of specific instruments utilized in clinical nuclear medicine. Emphasis will be placed on the performance of more advanced studies in *in vitro* and *in vivo* procedures employing radioisotopes and practical therapeutic use of radionuclides.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 36

QUARTER HOURS CREDIT: 12

PREREQUISITE: NMT 279 Practicum IV

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: The student will be able to:

1. Gain a functional understanding of the basic techniques and principles of *in vivo* and *in vitro* procedures.
2. Get a good understanding of the interpretative value of each procedure.

COURSE OUTLINE:

I. Supervised Learning Experiences in Clinical Facilities

II. Comprehensive Written Examination

NMT 251 PRINCIPLES OF NUCLEAR MEDICINE IV

PLACEMENT: Eighth Quarter

COURSE DESCRIPTION:

Detailed theoretical consideration of standard *in vivo* laboratory tests and to radionuclide studies of the skeletal and urinary systems are stressed.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEXTBOOK:

Maynard, C. Douglas. *Clinical Nuclear Medicine*. Philadelphia: Lea & Febiger, 1969.

COURSE OBJECTIVE: To give the student a thorough knowledge of the fundamentals involved in the performance of these clinical procedures.

COURSE OUTLINE:

I. Laboratory Tests

  A. Schilling's
  B. Fat absorption
  C. Protein loss
  D. GI blood loss
  E. Ferrokinetics
  F. RBC mass
  G. Plasma volume
  H. RBC survival

II. Skeletal - Imaging

III. Bone Marrow - Imaging

IV. Renal

  A. Scanning
  B. Renogram
  C. Dynamic studies
  D. Transplant evaluation

REFERENCES:

Blahd, W., et al. The Practice of Nuclear Medicine. Springfield, Illinois: Charles C. Thomas, Publisher, 1968.

Silver, S., Radioactive Isotopes in Medicine and Biology - Medicine. Philadelphia: Lea & Febiger, 1962.

Wagner, Henry H., Principles of Nuclear Medicine. Philadelphia: W. B. Saunders Co., 1968.

NMT 290 NUCLEAR MEDICINE TECHNOLOGY SEMINAR

PLACEMENT: Eighth Quarter

COURSE DESCRIPTION:

A review of any specific topics of nuclear medicine technology of special interest to students. Papers on such topics will be presented by guest speakers.

COURSE HOURS PER WEEK: Class 2; Lab 0; Practicum 0

QUARTER HOURS CREDIT: 2

PREREQUISITE: None

SUGGESTED TEACHING METHODS: Methods of instruction will include student reports, guided discussion and film presentations.

COURSE OBJECTIVE: The student will be able to:

1. Display the ability to function within a nuclear medicine department.

2. Describe briefly the basic principles of nuclear medicine technology.

COURSE OUTLINE:

I. Supervised Classroom Discussions

    A. Clinical nuclear medicine
        1. _In Vitro_ procedures
        2. _In Vivo_ procedures
    B. Radiation safety
        1. Health physics
        2. Nuclear physics
    C. Instrumentation
    D. Radiopharmacy

II. Discussion of Challenging and Difficult Cases

NMT 283 OPEN LAB PRACTICUM IV

PLACEMENT: Eighth Quarter

COURSE DESCRIPTION:

Clinical experience conducted under evening and weekend emergency situations, with more emphasis on student participation in clinical procedures and patient contact.

COURSE HOURS PER WEEK: Class 0; Lab 0; Practicum 6

QUARTER HOURS CREDIT: 2

PREREQUISITES: NMT 278 Open Lab Practicum III: NMT 279 Practicum IV

SUGGESTED TEXTBOOK: None

COURSE OBJECTIVE: To acquaint the student with the procedures required for use during emergency situations.

COURSE OUTLINE:

I. Supervised Learning Experiences in Clinical Facilities

II. Transfer of Theory into Clinical Practice

III. Clinical Evaluation

APPENDICES

APPENDIX A

ESSENTIALS OF AN ACCREDITED EDUCATION PROGRAM

Introduction

The organization primarily concerned with the maintenance of acceptable standards for education programs for nuclear medicine technologists and technicians is the Council of Medical Education of the American Medical Association. The American College of Radiology, the Society of Nuclear Medicine, the American Society of Clinical Pathologists, the American Society of Medical Technologyists, the American Society of Radiologic Technologists, and the Society of Nuclear Medical Technologists have obvious interest and concern in such training. To organize their concerns and provide an orderly mechanism for preparation of recommendations to the Council on Medical Education, a single Board of Schools of Nuclear Medicine Technology shall be concerned with the evaluation and survey of educational programs for Nuclear Medicine Technologists and Technicians, the maintenance of high standards of education, and the development of new teaching programs.

The Board of Schools of Nuclear Medicine Technology shall consist of two representatives each from the American College of Radiology, the American Society of Clinical Pathologists, and the Society of Nuclear Medicine, and two representatives each, registered in nuclear medicine technology, from the American Society of Radiologic Technologists, the American Society of Medical Technologists, and the Society of Nuclear Medical Technologists.

The Board of Schools shall serve as the reviewing body for all educational programs for Nuclear Medicine Technology and make recommendations to the Council on Medical Education of the American Medical Association concerning approval status.

Nuclear Medicine Technologists and Technicians are trained in these programs to work under the direction of physicians qualified in the clinical use of radionuclides, and not to work as independent practitioners.

I. ADMINISTRATION

A. Acceptable schools for training in nuclear medicine technology may be conducted in approved medical schools, accredited colleges or universities, accredited general hospitals or other acceptable laboratories suitably organized in accordance with present educational standards. Facilities providing clinical services in nuclear medicine must be maintained. Such facilities must provide an adequate volume and variety of procedures in relation to student enrollment. Under special circumstances, programs may be developed in specialty hospitals, laboratories, or in general hospitals where experience may not be possible in the full range of radionuclides. In such cases, the institution may arrange for affiliation with some other facility to provide training and experience in desired procedures with the approval of the Board of Schools of Nuclear Medicine Technology.

B. Affiliation with an accredited community college or technical institute, university, or medical school is desirable but not essential. When such an affiliation exists, an advisory committee should be established consisting of representatives from the sponsoring institution and from the department of the educational institution or medical school which participates in the training program.

C. All training of technologists and technicians shall be under competant medical supervision.

D. Resources for continued operation of the school should be assured through regular budget, gifts, or endowments. A monthly stipend to the student may be permitted.

II. ORGANIZATION

A. The nuclear medicine faculty shall comply with federal, State and hospital regulations for safety procedures. Adequate space, light, and modern equipment should be provided in the training area.

B. A library containing up-to-date references, texts, and scientific periodicals pertaining to nuclear medicine technology should be readily accessible to students.

C. Satisfactory records must be kept for all work accomplished in the departments.

D. Transcripts of college credits and other credentials must be available. Records must be kept of each student's attendance and grades, as well as the number and types of technological procedures performed.

E. A current outline of the curriculum and the rotation of assignments must be available in the office of the program director.

F. Approval of a program may be withdrawn if no students are enrolled for a period of two consecutive years.

G. Institutions sponsoring programs for nuclear medicine technology should submit an annual report to the Council on Medical Education and to the Board of Schools of Nuclear Medicine Technology.

H. A periodic survey will be conducted by the Board of Schools of Nuclear Medicine Technology in collaboration with the Council on Medical Education. If the physician director in charge of the training program or the curriculum is changed, the Council shall be notified, and re-evaluation may be required.

III. FACULTY

A. The program must have a competent and adequate teaching staff. The director must be a physician qualified in the clinical use of radionuclides. He must be eligible for certification by a medical specialty examining board recognized by the American Medical Association, or have qualifications acceptable to the Council on Medical Education. He shall take part in and be responsible for the actual conduct of the training program and shall be in daily attendance for sufficient time to supervise properly the work and teaching in the department.

B. The teaching staff should include qualified instructors in radiation physics and radiation biology adequate for both group and individual instruction. It should also include at least one instructor who is a registered nuclear medicine technologist and who is actively engaged in nuclear medicine technology.

IV. ADMISSION REQUIREMENTS

Applicants must be at least eighteen years of age at the time they reach the training period when they will be working with radionuclides. Candidates for admission must satisfy one of the following minimal requirements:

A. For Associate Degree Programs; Technicians: Applicants must have successfully completed four years of high school or have passed a standard equivalency test for admission to a college. Successful completion of two years study, including the twelve month training program, may qualify the individual for an associate degree. For those who have successfully completed one year of college, including at least three credit hours in chemistry and mathematics, the twelve-month training program may qualify the individual for an associate degree.

B. Those registered as M.T. (ASCP); R.T. (ARRT); or R.N. may, by completing the twelve month training program, qualify for registration in Nuclear Medicine Technology.

V. CURRICULUM

The educational program shall be a minimum of 24 months. Adequate vacation periods should be allowed for each 12 months of training. Adequate clinical experience should follow a planned outline and include text assignments, lectures, discussions, demonstrations, supervised practice, practical examinations and quizzes.

The following suggested basic minimum curriculum is presented as a guide for an educational program in nuclear medicine technology:

Two-Year Course in Nuclear Medicine Technology with suggested order of presentation.

FIRST YEAR

FIRST QUARTER	THEORY CLOCK HOURS
Anatomy and Physiology I	24
General Chemistry I	24
Mathematics	18
Medical Terminology I	6
Nuclear Medicine Technology I	6
	78

SECOND QUARTER	
Anatomy and Physiology II	24
General Chemistry II	24
Mathematics	18
Medical Terminology II	6
Physics	18
Nuclear Medicine Technology II	6
	96

THIRD QUARTER	
Organic Chemistry	24
Fundamentals of Disease Processes	24
Physics	18
Topographical Anatomy	12
Nuclear Medicine Technology III	6
	84

FOURTH QUARTER	
Biochemistry	24
Film Processing	12
Nuclear Medicine Technology IV	12
Practicum I	24
	72

SECOND YEAR

FIFTH QUARTER	
Nuclear Physics	12
Practicum II	60
Principles of Nuclear Medicine I	12
Introduction to Radioimmunoassay	12
Open Lab Practicum I	12
	108

SIXTH QUARTER	THEORY CLOCK HOURS
Practicum III	60
Nuclear Medicine Instrumentation I	24
Principles of Nuclear Medicine II	24
Radiopharmaceuticals I	24
Health Physics	6
Open Lab Practicum II	12
	150
SEVENTH QUARTER	
Practicum IV	60
Nuclear Medicine Instrumentation II	24
Principles of Nuclear Medicine III	12
Radiobiology	12
Radiopharmaceuticals II	12
Open Lab Practicum III	12
	132
EIGHTH QUARTER	
Practicum V	72
Principles of Nuclear Medicine IV	12
Nuclear Medicine Technology Seminar	12
Open Lab Practicum IV	12
	108

The hours indicated are only suggestions and not essential, provided an adequate total education program is offered.

VI. ETHICS

Excessive student fees and commercial advertising are considered unethical. Educational programs must not substitute students for paid technologists and technicians.

VII. HEALTH

Applicants for admission to an acceptable educational program shall be required to submit evidence of good health and successful vaccinations, and a report of a medical examination should be a part of student records. Health care and hospitalization shall be available to the student.

VIII. ADMISSION TO THE APPROVED LIST

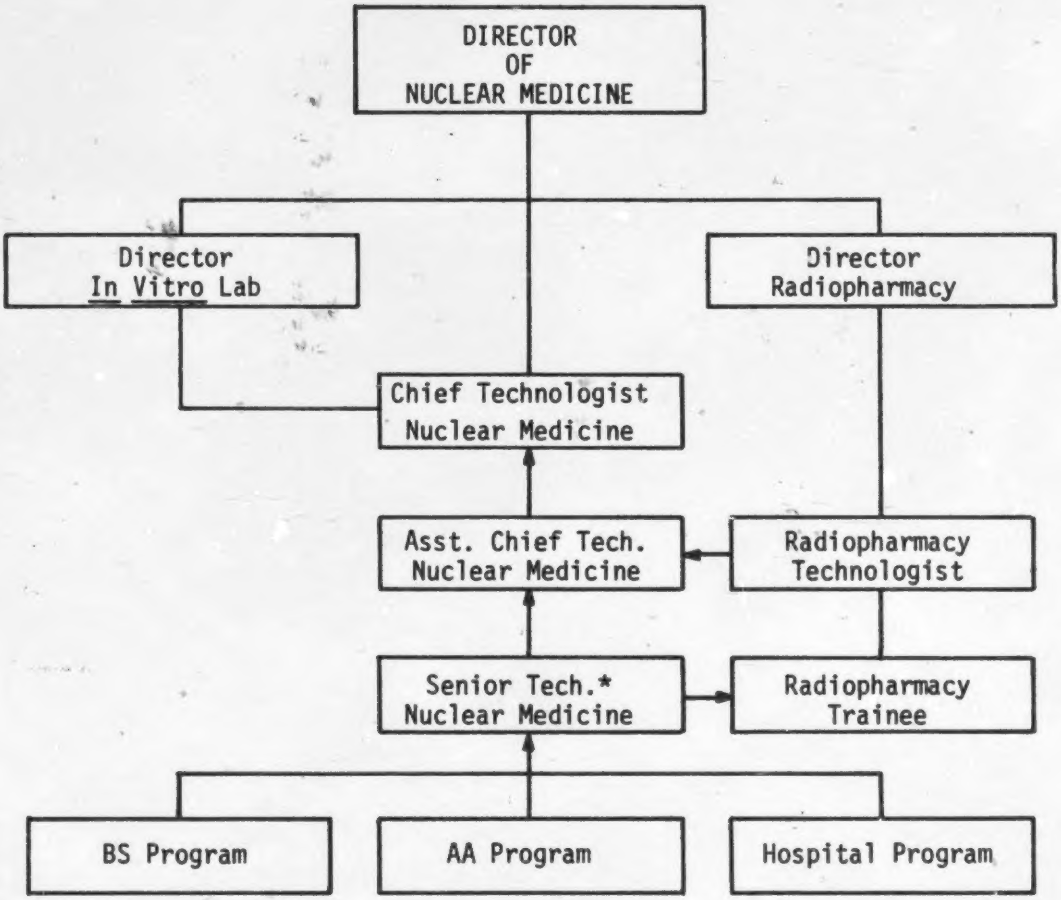
Application for approval of an educational program in nuclear medicine technology should be submitted to the Department of Allied Medical Professions and Services, Division of Medical Education, American Medical Association, 535 North Dearborn Street, Chicago, Illinois 60610. Forms will be supplied for this purpose on request and should be completed by the director of the institution requesting approval.

Approval may be withdrawn whenever, in the opinion of the Council on Medical Education, a school does not maintain an educational program in accordance with the minimum standards stated above.

APPENDIX B

JOB DESCRIPTIONS

A POSSIBLE CAREER SCHEMATIC FOR NUCLEAR MEDICINE TECHNOLOGISTS BASED ON EDUCATION AND PROMOTIONAL DESCRIPTION


DIRECTOR OF NUCLEAR MEDICINE
Director In Vitro Lab
Director Radiopharmacy
Chief Technologist Nuclear Medicine
Asst. Chief Tech. Nuclear Medicine
Radiopharmacy Technologist
Senior Tech.* Nuclear Medicine
Radiopharmacy Trainee
BS Program
AA Program
Hospital Program

*R.T. or M.T. in Nuclear Medicine - Desirable that all above this level meet the requirements for registry by ARRT or ASCP.

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JOB DESCRIPTION I: STUDENT TECHNOLOGIST

Administrative Responsibilities:

1. Maintains adequate records as directed.
2. Maintains orderliness and cleanliness.
3. Secures and returns supplies.
4. Cooperates with all personnel in the proper conduct of the department.
5. Rotates within the department as required.
6. Maintains ethical relationships.

Continuous Training:

1. May be required to assist in the development of new scanning techniques.
2. May assist in the use of a variety of instruments or procedures not routinely taught.
3. Performs other related duties as required.

Qualifications:

1. High school graduate or equivalent.
2. Satisfactory completion of formal nuclear medicine training in an AMA approved school and meets the requirements for registry by the ARRT.

Line of Promotion:

From Student Technologist to Senior Nuclear Medicine Technologist

JOB DESCRIPTION II: SENIOR NUCLEAR MEDICINE TECHNOLOGIST

Position Summary:

Performing a variety of technical procedures that require independent judgment, ingenuity and initiative in the utilization of radionuclides for the diagnosis and treatment of diseases in humans. Assuming responsibility for designated areas or procedures as required. Assigned duties as an instructor in areas of specific competence.

Minimum Qualifications Required:

Certification in Nuclear Medicine by the American Society of Radiologic Technology or the American Society of Medical Technologists

Line of Promotion:

From Senior Nuclear Medicine Technologists to Assistant Chief Technologist

Significant Duties:

1. Positions and transfers patients.
2. Provides immobilization devices as required.
3. Selects and operates equipment as directed.
4. Develops film by automatic or manual processing.
5. Provides protection in accordance with prescribed safety standards.
6. Assists the physician in the preparation and administration of radiopharmaceuticals to patients.
7. Delegates area of authority in the performance of routine or special procedures.
8. Responsible for specific areas of instruction of student technologists and ancillary personnel.
9. Performs radionuclide procedures on patients inclusive of organ imaging, function studies, in vitro tests, and assisting the physician in the therapeutic use of radioisotopes under prescribed safety conditions.
10. In the absence of the chief and assistant chief technologists, is designated as acting supervisor.
11. Assists in performing first aid as necessary.
12. Practices sterile techniques and prevents cross-contamination.
13. Prepares solutions, materials and instruments for sterilization.
14. Prepares radioactive tracer compounds for patient use.
15. Calibrates equipment and radioisotope assay operations.
16. Explains procedure.
17. Venipuncture.
18. Performs other related duties as required.

Administrative Responsibilities:

1. Maintains records of radioisotope receipt, use, storage, and disposal in accordance with State and federal regulations governing the accountability for radioactive materials. Maintains other records as directed.
2. Maintains orderliness and cleanliness, including provisions for the contamination-free condition of rooms, equipment, and personnel.
3. Secures and returns supplies.
4. Cooperates with all personnel in the proper conduct of the department.
5. Maintains ethical relationships.

Continuous Training:

1. May be requested to assist in the development of techniques for procedures.
2. May assist in the use of a variety of equipment and procedures not routinely employed.
3. Should take advantage of opportunities for continuing education in Nuclear Medicine Technology.

JOB DESCRIPTION III: ASSISTANT CHIEF NUCLEAR MEDICINE TECHNOLOGIST

Position Summary:

Supervision of the quality and quantity of work of the senior technologists in the routine radiochemical analyses performed in the Nuclear Medicine laboratory. Such supervision entails continuous decision-making as to the acceptance, scheduling, performance of analyses and reporting of results on patient samples tested in the laboratory as well as assigning work loads and keeping the technologists under his/her supervision supplied with the appropriate materials.

Minimum Requirements:

1. Registered Medical Technologist (ASCP); or
2. Registered Nuclear Medicine Technologist (ARRT); plus
3. Minimum of 2 years clinical experience in Nuclear Medicine Wet Lab procedures, and the ability to supervise other employees

Other Desirable Qualifications:

1. Academic training or work experience in endocrinology
2. Bachelor's degree in related science
3. Demonstration of teaching ability
4. Stable, mature patient-oriented personality

Significant Duties:

1. Supervises collection of proper blood specimens.
2. Has a working knowledge of every test offered by the laboratory in order to relieve technologists performing routine testing when neccessary.
3. Performs the more complex analyses not routinely done in lab but set up specially in consultations with clinical staff (chromatography, serum fractionation, etc.)
4. Prepares the more complex reagents for the laboratory so that expensive commercial reagents need not be purchased routinely.
5. Performs the periodic general maintenance needed to keep the laboratory instruments and equipment in good operating condition.

Administrative Responsibilities:

1. Schedules work among technologists so that the work load is evenly distributed on a daily basis.
2. Orders and inventories radioisotopes and other materials to insure adequate stocks exist as needed.

3. Maintains and analyzes quality control records to insure highest testing standards.
4. Maintains records of laboratory work load for business office.
5. Schedules work assignments among technologists so that "call" and weekend coverage for laboratory is provided as may be required.
6. Acts as intermediate with clinical staff on all questions of routine testing (e.g., condition of patient for proper blood sample, status of analysis of given to patient sample for projected report date, etc.).
7. Maintains orderliness and cleanliness, including provision of safety equipment and decontaminiation when necessary.
8. Coordinates interaction of laboratory with personnel in other parts of Nuclear Medicine division and the hospital in general.

Continuous Training:

1. Teaches other technologists in new methods as they are developed by the Laboratory Director.
2. Instructs technology students in the performance of the routine analyses.
3. Describes techniques and methods used in the laboratory analysis of patient samples to new interns and residents when requested.

JOB DESCRIPTION IV: CHIEF NUCLEAR MEDICINE TECHNOLOGIST

Position Summary:

Supervising and performing duties directly involved with a variety of technical procedures in the application of radionuclides for the diagnosis and treatment of disease in humans. Supervises technologists and ancillary personnel assigned within specified areas, recommends the scheduling of personnel and equipment repairs, and evaluates work progress within those areas of designated responsibility.

Minimum Qualifications Required:

1. Certification in Nuclear Medicine by the American Society of Radiologic Technologists or the American Society of Medical Technologists
2. Experience in an approved Nuclear Medicine Department with supervisory ability demonstrated

Other Desireable Qualifications Include:

1. Bachelors degree in a related science
2. Supervisory development courses
3. Teaching experience

Line of Promotion:

From Assistant Chief Nuclear Medical Technologist to Chief Nuclear Medical Technologist

Significant Duties:

1. Evaluates services and maintains standards of quality. Directs technologists, orderly, secretary, film librarian, and students with regard to schedules, work areas, conduct, attendance, and other related matters.
2. Meditates individual problems relating to staff, morale, scheduling, work methods, procedures, salary adjustments, discipline, transfers, safety, and other actions regarding assigned personnel.
3. Participates in the formal in-service training programs of the department instructing the demonstration of specific techniques and equipment. Keeps abreast of new procedures, equipment and methods, participating in their evaluation and application.
4. Under the direction of the Hospital Radiation Safety Officer, is responsible for all safety regulations within the department. Interprets departmetal and hospital regulations and rules where applicable to personnel.
5. Procures, stores, and routes supplies. Recommends procurement and necessity for repair of equipment.
6. When requested by the Nuclear Medicine Director, participates in the formulation of department policies which pertain to areas of responsibility.
7. Interviews, selects, and recommends hiring and firing of employees.
8. Under the direction of the Nuclear Medicine Director, develops department budgets.
9. Maintains business records of department, including billing arrangements, budgets, pay records.
10. Maintains personnel records of all personnel in department.
11. Is responsible for non-technical, non-professional personnel in department.
12. Acts as primary liaison with members of administration, with particular concern in areas of purchasing and personnel policies.
13. Acts as liaison with responsible administrative officials of all other medical and educational facilities cooperating in joint training programs in Nuclear Medicine Technology.
14. Acts with physician-director in originating and maintaining contractual agreements of the Nuclear Medicine Department.
15. Performs other duties as assigned.

JOB DESCRIPTION V: RADIOPHARMACY TECHNOLOGIST TRAINEE

Position Summary:

Comprehending the theoretical aspects of the preparation and clinical use of radiopharmaceuticals, the instrumentation used in the detection of radiation; the theory and practical aspects of radiation protection; and a mastery of the skills required to assist the radiopharmacist in the procurement, preparation, quality control and dispensing of radiopharmaceuticals. (The Director of Radiopharmacy will decide when the trainee is prepared to be promoted to the position of Radiopharmacy Technologist.)

Minimum Qualifications:

1. Bachelors degree in a physical or biological science
2. Experience in chemical laboratory procedures
3. Nuclear Medicine Technologist, Board
4. Certified by ARRT or the ASMT

Line of Promotion:

From Radiopharmacy Technologist Trainee to Radiopharmacy Technologist

Significant Duties:

1. Assists the radiopharmacist (on the job training).
2. Prepares radiopharmaceuticals for use by the Nuclear Medicine Laboratory.
3. Procures and maintains the radiopharmaceutical inventory.
4. Makes quality control analyses of all radiopharmaceuticals to determine:
    a. Sterility and apyrogenicity.
    b. Activity, concentration and pH.
    c. Radionuclidic and radiochemical purity.
5. Prepares and analyses non-radioactive reagents.
6. Maintains State-required records of radiopharmaceutical acquisition and disposition.
7. Performs other duties as assigned.

JOB DESCRIPTION VI: RADIOPHARMACY TECHNOLOGISTS

Position Summary:

Procurement, preparation, quality control and dispensing of radiopharmaceuticals.

Minimum Qualifications Required:

1. Bachelor's degree with a minimum of 18 semester hours in the physical or biological sciences; or equivalent training and/or experience
2. Experience in clinical laboratory procedures

3. Training period of at least 3 months in the use and handling of radioactive materials (may be obtained on-the-job)
4. Registered Nuclear Medicine Technologist, ARRT or ASCP, with 3-6 months of concentrated training and/or experience in radiopharmacy techniques

Significant Duties:

1. Prepares radiopharmaceuticals for use by the Nuclear Medicine Laboratory and area hospitals procuring radiopharmaceuticals from NCBH.
2. Procures and maintains the radiopharmaceutical inventory.
3. Makes control analyses of all radiopharmaceuticals to determine:
    a. Sterility and apyrogenicity.
    b. Activity, concentration and pH.
    c. Radionuclidic and radiochemical purity.
4. Prepares and analyses non-radioactive reagents.
5. Maintains State-required records of radiopharmaceutical acquisition and disposition.
6. Directs trainees and students in laboratory experiments.
7. Assists the radiopharmacist in the chemical aspects of radiopharmacy research.
8. Performs other duties as assigned.

APPENDIX C

EQUIPMENT LIST: 221 Nuclear Medicine Technology
Code No. Name of List

$ 50,360.40
Cost

14 students
Supporting Base

THIS EQUIPMENT LIST SHOULD BE REVIEWED WITHIN TWO YEARS AFTER ITS EFFECTIVE DATE.

NEW LIST ☒ XX

REVISED LIST ☐ Please destroy cover and pages _____ dated ___________

Replace with cover and pages attached.

DEPARTMENT OF COMMUNITY COLLEGES
PROGRAM DEVELOPMENT

Date: February, 1975

COMMITTEE

Mrs. Vercie M. Eller	Department of Community Colleges Raleigh
Mr. David Hunter	Forsyth Technical Institute Winston-Salem
Mr. Jim Winning	Forsyth Technical Institute Winston-Salem
Dr. C. D. Maynard	Bowman-Gray School of Medicine Winston-Salem
Dr. Robert J. Cowan	Bowman-Gray School of Medicine Winston-Salem

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Code No.	Name of List	

ITEM NO.	QUANTITY	DESCRIPTION	COST OF ITEM	TOTAL
*1.	10	0-200 mR pocket dosimeter	44.55	445.50
*2.	1	Dosimeter/charger storage case	76.50	76.50
*3.	1	Decontamination kit	95.00	95.00
*4.	1	Organ scanning phantom	740.00	740.00
*5.	1	Simulated Liver Organ	120.00	120.00
*6.	1	Simulated pancreas	60.00	60.00
*7.	1	Simulated spleen	65.00	65.00
*8.	1	Set of seven tumors	70.00	70.00
*9.	1	Brain scanning phantom system	275.00	275.00
*10.	1	GM tube with slotted stand and cable	110.00	110.00
*11.	1	Lead shield for GM tube	50.00	50.00
*12.	1	High voltage power supply	295.00	295.00
*13.	1	Absorber set	110.00	110.00
*14.	1	Counter/timer	600.00	600.00
*15.	1	Minbin and power supply	440.00	440.00
*16.	1,000	Aluminum planchets	30.75	30.75
*17.	1	Set of five calibrated beta sources	100.00	100.00
*18.	1	Set of split beta sources	12.50	12.50
*19.	1	Flood phantom disc	105.00	105.00
*20.	1	Rod sources for scintillation	155.00	155.00

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Code No. Name of List

ITEM NO.	QUANTITY	DESCRIPTION	COST OF ITEM	TOTAL
*21.	1	^{129}I standard calibrating source	52.00	52.00
*22.	1	3" x 3" integral well assembly	990.00	990.00
*23.	1	1-3/4" x 2" integral well assembly	315.00	315.00
*24.	1	2" photomultiplier tube	85.00	85.00
*25.	1	3" photomultiplier tube	150.00	150.00
*26.	2	14 Pin photomultiplier tube base with built in preamplifier	200.00	400.00
*27.	2	Linear amplifier	460.00	920.00
*28.	2	Power supply	425.00	850.00
*29.	2	NIM Bin and Power supply	440.00	880.00
*30.	1	NIM Pulser	225.00	225.00
*31.	1	Digital Baseline Sweep	510.00	510.00
*32.	2	Ratemeter	295.00	590.00
*33.	1	Howler	175.00	175.00
*34.	1	Strip Chart Recorder	795.00	795.00
*35.	1	Magna Scanner 500D (3") including: 1 #612-974 high efficiency coarse collimator, 1 #612-294 high energy, fine focus collimator, 1 #612-692 low energy , medium focus collimator, 2 cassettes, 1 #2809J Ultraprobe (3") Teledeltos Printer	15,320.00	15,320.00

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Code No.	Name of List	

ITEM NO.	QUANTITY	DESCRIPTION	COST OF ITEM	TOTAL
*36.	1	Spectroscaler 4 with 1 #621-941 1-3/4" x 2" NaI (Tl) well crystal	4,070.00	4,070.00
*37.	1	High Voltage Power supply	425.80	425.80
*38.	1	Amplifier	410.00	410.00
*39.	1	Preamplifier	425.00	425.00
*40.	1	NIM Bin	575.00	575.00
*41.	1	Ge(Li) detector	4,625.00	4,625.00
*42.	1	Teletype/Punch	1,455.00	1,455.00
*43.	1	4096 Multi Channel Analyzer	11,450.00	11,450.00
*44.	1	Selectapette Pipet	59.95	59.95
*45.	1	Pipet, Bioquest	49.95	49.95
*46.	1	Interval Timer	15.95	15.95
*47.	1	Magnetic Stirrer	48.50	48.50
*48.	1	Maxi-Mix	70.00	70.00
*49.	1	Electrodes, pH meter	68.00	68.00
*50.	1	GM-Survey Meter with SK-1 speaker and HP-177B probe	400.00	400.00

APPENDIX D

SUGGESTED SUPPLIES

CONSUMABLE REAGENTS

1. T_4	$278.00
2. Digoxin	101.64
3. Digitoxin	111.96
4. HAA	154.44
5. Insulin	130.00

CONSUMABLE GLASS AND PLASTICS

1. Plastic Test Tubes	$ 65.93
2. Liquid Scintillation Vials	32.86
3. Plastic Pipet Tips for Selectapette	25.35
TOTAL - - - - - - - - - -	$900.18

UNIVERSITY OF CALIF.
LOS ANGELES

DEC 10 [illegible]

CLEARINGHOUSE FOR
JUNIOR COLLEGES